वसुदेवसुतं देवं कंसचाणूरमर्दनम् ।
देवकीपरमानन्दं कृष्णं वन्दे जगद्गुरुम् ।५।

I salute krishna, the guru of the universe, God, the son of Vasudeva, the destroyer of Kamsa and Canura, the supreme bliss of Devaki.

DEDICATED

TO

PARENTS AND SISTER

C E R T I F I C A T E

This is to certify that this Dissertation entitled **ACOUSTIC AND PERCEPTUAL ANALYSIS OF THE SPEECH OF NORMAL GERIATRICS AND DYSARTHRICS** is the bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student with Register No. M 9704.

Mysore

May, 1999

Dr. (Miss) S. **Nikam**
Director
All India Institute of Speech and Hearing
Mysore - 570 006

CERTIFICATE

This is to certify that this Dissertation entitled ACOUSTIC AND PERCEPTUAL ANALYSIS OF THE SPEECH OF NORMAL GERIATRICS AND DYSARTHRICS , has been prepared under my supervision and guidance.

Mysore

May, 1999

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D E C L A R A T I O N

This Dissertation entitled *ACOUSTIC AND PERCEPTUAL ANALYSIS OF THE SPEECH OF NORMAL GERIATRICS AND* ***DYSARTHRICS*** is the result of my own study under the guidance of Dr. R. MAINJULA, Clinical Lecturer, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore

May, 1999 *Reg. No. M 9704*

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INTRODUCTION

The lives of all multicellular organism begin with conception, extend through phases of development, maturity, senescence and finally end in death. Man is no exception. Aging is one of the most universal and inevitable social and scientific challenges confronting man. Several studies (Sabin and Veena 1984, Cotman and Anderson, 1991) have found that advancing age is characterized by a progressive and insidious decline in functional capacity of most physiological systems. Some of the most physical deterioration associated with an aging organism is genetically predetermined and some of the deterioration is a function of environmental influences. Birren (1964) has argued that in humans, hereditary factors may be less important than environmental factors.

Communication is the most significant characteristic of human being throughout the entire span of life. The acquisition, development and maintenance of communication capabilities in human beings are dependent on the adequate functioning and appropriate integration of distinct neural networks,. Physiological alterations that accompany the aging process produces predictable changes in the acoustic parameters of speech (Hutchinson and Beasley, 1976). Aging persons are particularly susceptible to neurological degeneration

and disease that interrupt normal language functioning and the peripheral execution of speech events. (Hutchinson and Beasley 1976).) There are several neurological disorders that occur in elderly; adult dysarthria is one among them. Darley, Aronson and Brown (1969) considered dysarthria to be a collective name for a group of speech disorders resulting from disturbances in muscular control over the speech mechanism due to damage to the central or peripheral nervous system. It designates problems in oral communication due to paralysis, weakness or in co-ordination of the speech mechanisms.

Information on changes in speech due to normal aging process is important in understanding effects of aging in neuromomuscular control of speech Data on geriatric changes in the neuromuscular control of speech are fragmentary. Few reports have been published to describe changes in speech motor function that might normally accompany the aging process. (Ptacek et al. (1966), Ryan and Burk (1974), Hartman (1979). Although such changes are subtle, they could be important in understanding the aging process and disease that are commonly seen in aged persons. (Kent and Burkard, 1981). Earlier, investigators were inclined to consider aging changes as correlates of specific disease syndromes. However, a possible distinction between aging changes per se and

the pathological changes which are commonly recognized as being associated with, or part of, specific disease syndromes has been recognized. (Tomlinson 1972, Shefer 1972, Colon 1972). According to Brizzee "The validity of the possible distinction between normal or "Physiological" aging and "Pathological" aging has not been firmly established. The probability of the essential distinctness of the two processes cannot be lightly discarded without a much greater amount of relevant experimental evidence." Review of literature suggests that there were very few studies which attempt to explore the distinct features of speech in normal geriatrics (physiologically aged) and dysarthrics (pathologically aged).

Hence the study was planned to explore and compare the perceptual and acoustic features of speech in normal geriatric and dysarthric groups of subjects.

OBJECTIVES OF THIS STUDY:

i) To perceptually and acoustically analyze the words consisting of /k/ and /g/ phonemes in various CV combinations uttered by the dysarthrics and the normal geriatric subjects.

ii) To study the features which were exclusive in dysarthrics and normal geriatrics.

iii) To study the features which overlapped in the normal geriatrics and dysarthrics.

HYPOTHESIS:

1. There are no perceptual features in the speech of normal geriatrics and dysarthrics which overlap.

2. There are no acoustic features in the speech of normal geriatrics and dysarthrics which overlap.

METHODOLOGY:

Twenty male subjects (Ten dysarthrics and Ten normal geriatrics) were made to utter 48 Kannada words which were considered for perceptual and acoustic analysis. These words had /k/ and /g/ as key phonemes which were combined with both short and long vowels and they occurred in all the three (initial, medial and final)positions. For perceptual analysis, the speech sample of all the subjects were played to an experienced Speech Pathologist who had to rate the speech against 31 speech dimensions derived on a 5 point rating

scale, (adopted from Darley et al. (1969) and Ingram et al. (1981). The judge was instructed to concentrate on the key phonemes /k/ and /g/ while rating for the different speech dimensions. For acoustic analysis, SSL (Speech Science Lab) program of **'VAGHMI'** software package (Voice and Speech System) was used. The following parameters were analyzed

- Proceeding Vowel Duration (PVD)
- Following Vowel Duration (FVD)
- Closure Duration (CD)
- Burst Duration (BD)
- Voice Onset Time (VOT)
- Syllable duration(SD)
- Transition Duration (TD)
- Speed of Transition (ST)

IMPLICATIONS OF THIS STUDY:

This study will

(a) provide insight into the age related perceptual and acoustic changes seen in the speech characteristics of the normal geriatrics and adult dysarthrics.

(b) enable to highlight those speech parameters if any, which are shared/not shared by the normal geriatrics and

dysarthrics. This in turn will throw some light on the existence or otherwise of distinct or common clusters of speech symptoms in normal geriatrics, thus rendering significant bearing in the diagnostic consideration of these two groups.

LIMITATIONS OF THE STUDY:

1. Only 10 UMN type of male adult dysarthrics were considered for this study.

2. Consideration of /k/ and /g/ phonemes in initial and medial position of the words would have sufficed for the extraction of acoustic parameters selected for this study. However, these phonemes were sampled in initial, medial and final positions of words in order to look for perceptual effects if any in the three positions of the word.

3. For perceptual data analysis only one judge was considered due to time constrains.

REVIEW OF LITERATURE

Man is unique and there are several and varied features that segregate him from the animals. Included are features such as the ability to use complex tools, thumb which moves in opposition to other fingers, power of reason and abstraction, above all, not to forget the utility and beauty of speech. (Beasley, 1981).

Man is a talking, thinking, social person, but he is also a biological system with a species specific life span (Birren, T959). The life cycle can be viewed as beginning with conception and ending with death. The representative phases of the life cycle includes development, maturity and senescence/aging.

Many investigators have reported changes occurring during specific phases of the life cycle. Age per se is not a deterrent to good communication. Actually communication may be facilitated because the aged person has a life time of talking and listening experience, a life-time of living and carrier experience from which to draw conversational material and perhaps a growing physical dependency that necessitates communication. (Oyer, 1976).

Increasing age, however does bring physiologic changes to the hearing, language and speech mechanism, which may alter one's communicative effectiveness. Ptacek and Sander (1966) performed a study whereby the ability of 10 listeners to differentiate between the voices of younger adults (<25 yrs.) and of older adults (>65 yrs.) was examined. The results indicated that listeners were able to differentiate between the two with considerable degree of accuracy.

Shipp and Hollein (1969) investigated more refined age identification by audition. Male speakers ranging in age from 20-89 years prolonged a vowel, extemporaneously spoke for one minute and read aloud the first paragraph of the 'Rainbow Passage'. They found that listeners were able to classify the talker on the basis of possible age. These findings suggest strongly that there is a perceptually identifiable parameter/a set of parameters in speech sample that can be identified as that of age.

STUDIES ON AGE RELATED CHANGES

Respiratory - Phonatory Function : Hollien and Shipp (1972) confirmed the findings of other investigators that the adult male voice is characterized by a saucer type curve with decrease in pitch

with each decade upto 50 years after which there is increase in pitch for each remaining decade of life.

Mc. Glone and Hollien (1963) measured the pitch level and pitch variability in two groups of aged women. Group I with age range of 65-79 and Group II with age range of 80-94 years. Speech sample of the subjects was obtained by recording the reading sample of 'Rainbow Passage'. They found that the mean F0 was lower in Group II.

Honjo and Isshiki (1980) studied both aged males and females and reported that men experience vocal fold atrophy which resulted in increase in F0 with advancing age, whereas females demonstrated vocal fold oedema and slight hoarseness with a lower F0. They also found that pitch variability decreased in Group II, i.e. pitch variability decreased with advancing age in females. In contrast to this, Mysak (1959) had found that there was greater pitch variability in older males.

Platek et al (1966) compared vowel prolongations of males and females in two age groups, those under 40 years and those over 65 years. Maximum vowel duration of sustained [a] for the males declined by 26% between young and old age groups whereas in

females it reduced by 32% with advancing age.) Similar results were reported by Kruel (1972) and Smith et al (1987). He found that elderly subjects had vowel prolongations that were 19-26% shorter than that of the younger subjects.

Hoit, Solomon and Hixon (1993) investigated the effects of lung volume on Voice Onset Time (VOT). VOT was determined for each stressed syllable /pi/ production at throe lung volume measures. It was found that VOT decreased with decreased lung volume (i.e.,) VOT decreased with advancing age.

Articulatory Function: Studies on articulatory changes in aging population is relatively less compared to the studies on respiratory and phonatory changes in aging individuals. Imprecise consonant production and slow rate of articulation are the important articulatory features of aging according to Ryan and Burk (1974).

Ryan and Burk (1974) carried out an experiment to find out the factors which best related to perceived age. Perceptual judgements were made by 20 trained listeners to estimate the age of 80 adult male speakers. Results indicated that laryngeal tension , voice tremor, air loss, imprecise consonants and slow rate of articulation were strong predictors of *age.* Hartman (1979) also reported similar

results. They also expressed that the speech of the aged falls at the mild end of dysarthria continuum.

STUDIES ON SPEECH SYSTEM IN DYSARTHRICS:

The abnormalities that could conceivably interfere with speech production in dysarthirics includes

Inflexible breathing pattern
(Cramer, 1940, De-La Torre et al. 1960, Laszewski 1956).

Rapid respiratory rate
(Ewanoswki 1964, Kim 1968).

Poor synchronization of respiration with speech
(Cramer 1940, Ewanoski 1964)

Reduction in vital capacity
(Cramer 1940, Laszewki 1956)

Murdock,Bowler Chenery, Ingram (1989). studied the respiratory abilities of a group of 19 parKinsonian subjects using spirometric and kinematic analysis. Spirometric assessment of respiratory function was done to yield measures of respiratory rate, vital capacity etc whereas the kinematic analysis involved simultaneous, but independent, recording of changes in the circumference of rib

cage and abdomen. Respiratory function of parkinsoninas was assessed during non-speech and speech performances. Speech tasks included syllable repetition, vowel prolongation, reading and conversation. Results showed that approximately half of the subjects showed irregularities in chest wall movement during production of sustained vowels and syllable repetitions. It can be concluded that chest wall movements were related to parkinsonism.

Duffy based on the results of several studies summarized the speech system errors in different types of dysarthrics as follows:

(i) Flaccid Dysarthric:

Respiratory - Reduced vital capacity

Termination of speech at larger than normal lung volume.

Larger than normal rib cage volume.

Abnormal chest wall movement

Neck and glossopharyngeal breathing.

Laryngeal
Respiratory level

Vocal cord immobility/sluggishness.

Incomplete glottal closure.

Abnormal vocal cord frequency and amplitude perturbation.

Increased amplitude of vocal cord mucosal wave.

Increased airflow rate.

Increased inspiratory volume.

Increased breath per minute.

Reduced pause frequency and duration.

Reduced syllables per breath group/speech duration.

Reduced range and variability of FO.

High amplitude of FO with reduced energy of harmonics.

Reduced format intensity.

Increased high frequency spectral energy.

Velopharyngeal

Increased frequency of FO.

Decreased energy in FO.

Increased nasal air flow.

Anti resonances.

Reduced overall intensity and intensity range.

Increased formant bandwidth.

Lingual

Reduced sustained lingual force.

(ii) ***Spastic Dysarthric:*** (based on spastic cerebral palsy)

Respiratory

Reduced inhibitory and exhibitory volumes.

Reduced respiratory intake.

Reduced vital capacity.

Reduced rate of amplitude variations.

Laryngeal

Decreased fundamental frequency variability.

Decreased vocal cord abduction during respirtion.

Decreased hyperadduction of true and false cords during speech.

Velopharyngeal

Increased pharyngeal constriction.

Slow, sluggish velopharyneal movement.

Articulatory

Reduced overall speech rate.

Reduced VOT for stops.

Reduced release bursts for stops

Reduced tongue strength.

Reduced completeness of articulatory contacts and consonant clusters.

Reduced range and movement of tongue and jaw.

Reduced acceleration and decceleration of articulators.

Increased syllable and word duration.

Prolongation of phonemes.

Centralization of vowel formants.

Slow phoneme - phoneme transition.

Increased spirantization during stops.

(iii) Ataxic Dysarthric:

Respiratory/Laryngeal

Increased variability of FO.

Reduced vital capacity.

Abnormal and paradoxical rib cage and abdominal movements.

Articulatory

Increased syllable and formant transition duration.

Longer VOT and lengthened consonant clusters.

Slow movements of lip, tongue and jaws.

Disproportionate lengthening of lax/unstressed vowels.

Increased variability of intensity rate and segment duration.

Reduced spacing between syllabic nuclei.

Reduced variability of syllable duration.

Occasional failure of articulatory contact for consonant.

(iv) Mixed Dysarthric:

Respiratory

Reduced vital capacity.

Chest wall muscle weakness.

Laryngeal

Abnormal FO (high/low).

Abnormal Jitter, Shimmer, H/N ratio

Decreased maximum vowel duration.

Velopharyngeal

Difficulty maintaining velar elevation.

Articulatory

Slow, single and repetitive articulatory movements.

Blurring of voiced - voiceless distinction.

Increased stop - gap duration.

Reduced maximum force of lip, jaw and tongue movements.

Excessive jaw movements

Reduced velocity and range of movement of articulators.

Reduced/flattened FO slope within words.

Increased vowel duration within syllables.

v. Hypokinetic Dysarthric:

Respiratory

Reduced vital capacity.

Reduced inter oral pressure.

Reduced syllable per breath group

Reduced amplitude of chest wall movement.

	Reduced airflow volume during vowel prolongation.
	Irregular breathing pattern.
	Increased respiratory rate.
	Increased latency to begin exhalation.
	Increased latency of initiation of phonation after exhalation initiated.
Laryngeal	
	Increased fo, glottal resistance shimmer
	Poor pitch control
	Decreased intensity, pitch and intensity variability.
	Asymmetrical movements of laryngeal structures during phonation.
	Bowed vocal cords.
	Ventricular fold movement during phonation.
	Continuous voicing in voiceless consonant segments.
	Voiceless transition from vowels to following consonants.

Velopharyngeal:

Increased nasal air flow

Decreased velar movement

Abnormal speed of nasalization during speech.

Articulatory

Spirantization of stops and affricates.

Jaw stability during vowel prolongation.

Reduced first and second transition rate.

Reduced tongue endurance and strength.

Reduced amplitude of lip movement.

- Jaw stability during vowel prolongation

Reduced ability to increase rate of speech on request.

Articulatory undershoot of lips and velum.

ASSESSMENT OF SPEECH:

Assessment of speech serves several purposes:

Overall index of severity of the disorder can be assessed thus allowing comparisons of different dysarthric speakers.

Evaluates and quantifies change in speech production skills resulting from spontaneous recovery and intervention effects within a speaker.

Assessment is an objective measure of the influence of the speech production deficit on a listener.

When asked to determine whether an adult has a speech disorder due to motor control problem, few measurement tools are available to the speech pathologist for providing a definite answer. One of the measurement tool is perceptual rating system where speech of the dysarthric is recorded and rated on the provided rating scales for different speech attributes. Objective technique is another measurement tool where instruments are used. Acoustic analysis of speech is one of the objective method of assessment.

PERCEPTUAL ANALYSIS OF SPEECH:

Darley, Aronson and Brown (1969) categorized the perceptual speech characteristics of different types of dysarthrias for differential diagnosis.

They collected speech samples from a total of 212 patients belonging to the following 7 neurological categories.

Pseudobulbar Palsy

Bulbar Palsy

Amyotrophic lateral sclerosis

Cerebellar lesions

Parkinsonism

Dystonia

Choreoathetosis

Each speech sample was rated by the authors on a series of 38 speech dimensions. The 38 dimensions can be grouped into seven categories for convenience.

(i) Four (1-4) dimensions pertaining to pitch -pitch level, pitch breaks, monopitch, and voice tremor.

(ii) Five (5-9) dimensions pertaining to loudness - mono loudness, excess loudness variation, loudness decay, alternating loudness and overall loudness.

(iii) Nine(10-18) dimensions pertaining to vocal quality including both laryngeal and resonatory dysfunction-harsh voice, hoarse wet voice, breathy voice(continuous), breathy Voice(transient), strained-

Strangled Voice, Voice stoppage, hypernasality, hyponasality and nasal emission.

(iv) Three (19-21) dimensions pertaining to respiration-forced inspiration-expiration, audible inspiration and grunt at end of expiration.

(v) Ten (22-31) dimensions pertaining to prosody: rate, phrases short, increase of rate in segments, increase of rate overall, reduced stress, variable rate, intervals prolonged, inappropriate, silences, short rushes of speech, excess and equal stress.

(vi) Five (32-36) dimensions pertain to articulation - imprecise, consonants, phonemes prolonged, phonemes repeated, irregular articulatory breakdown, and vowels distorted.

(vii) Two (37-38) dimensions for overall or general impression of speech - intelligibility and bizarreness.

Each patient's performance with regard to each dimension was rated through the use of a 7 point scale.

1- representing normal speech.

7- representing very severe deviation from normal.

They summarized the prominent speech deviations in each type of dysarthric according to the decreasing order.

(i) Bulbar Palsy:

Hypernasality

Imprecise consonants

Breathy voice (continuous)

Monopitch

Nasal Emission

Audible Inspiration

Harsh voice

Phrases short

Monoloudness

(ii) Pseudo bulbar Palsy:

Imprecise consonants

Monopitch

Reduced stress

Harsh voice

Mono loudness

Low pitch

Slow rate

Hypernasality

Strained - strangled voice

Phrases short

Vowels distorted

Pitch breaks

Breathy voice (continuous)

Excess and equal stress

(Hi) Amyotrophic Lateral Sclerosis:

Imprecise consonants

Hypernasality

Harsh voice

Slow rate

Monopitch

Phrases short

Vowels distorted

Low pitch

Mono loudness

Excess and equal stress

Intervals prolonged

Reduced stress

Phonemes prolonged

Strained - strangled voice

Breathy inspiration

Inappropriate silences

Nasal emission

(iv) Ataxic dysarthria with cerebellar disorders:

Imprecise consonants

Excess and equal stress

Irregular articulator breakdown

Vowels distorted

Harsh voice

Phonemes prolonged

Monopitch

Mono loudness

Slow rate

(iv) Hypokinetic Dysarthria in Parkinsonism group:

Monopitch

Reduced stress

Mono loudness

Imprecise consonants

Inappropriate silences

Short rushes

Harsh voice

Breathy voice

Low pitch

Variable rate

(v) Hyperkineic Dysarthria in Dystonia:

Imprecise consonants

Vowels distorted

Harsh voice

Irregular articulatory breakdown

Strained strangled voice

Monopitch

Mono loudness

Inappropriate silences

Phrases short

Intervals prolonged

Phonemes prolonged

Excess loudness variations

Reduced stress

Voice stoppages

Slow rate

(vii) Hyperkinetic Dysarthria in Chorea:

Imprecise consonants

Intervals prolonged

Variable rate

Monopitch

Harsh voice

Inappropriate silences

Vowels distorted .

Excess loudness variations

Phonemes prolonged

Mono loudness

Phrases short

Excess and equal stress

Irregular articulatory breakdown

Hypernasality

Reduced stress

Strained-strangled voicej)

Chenery, Murdock and Ingram (1988) compared perceptual speech characteristics of a group of 19 subjects with mild-moderate Parkinson's diseases with matched normal non-neurologically impaired control group. Each subject was asked to read. 'The

grandfather passage' and it was rated on 32 dimensions covering all the 5 aspects of speech production.

Speech deviation which most frequently occurred was hoarseness followed by deficits in loudness variations, strained strangulated phonation with intermittent breathiness. Disturbed prosodic features which was noted was a disturbed general stress pattern, lack of pitch variation and phrase length.

Parnell and Amerman (1987) judged the adequacy of oral DDK performances by 10 normal geriatric speakers, 10 normal young speakers and 4 dysarthric speakers. Listeners rated each speaker according to 11 perceptual dimensions.

Overall rate of syllable production.

Regularity of rhythm of syllable production.

Control of loudness.

Precision of consonant articulation.

Precision of vowel articulation.

Preservation of syllabic Integrity.

Sequencing of syllables

Voice quality.

Effort.

Intelligibility.

Overall impression of normalcy of performance.

They used a seven point severity scale. Results showed that the listeners rated the speech of normal geriatric subjects significantly higher on 7 point scale like that of dysarthric speakers. This suggests that the perceptual characteristics of motor speech ability (oral DDK) was significantly at variance for geriatrics when compared with that of normal adults.

ʳ *f* Hoodin and Gilbert (1989) studies the Velopharyngeal closure for speech in subjects with Parkinsonian Disease using aerodynamic and perceptual analysis. Aerodynamically, Velopharyngeal closure was indexed by obtaining rates of nasal air flows and perceptually by scaling listener judgement of hypernasality and articulatorily by administering Iowa Pressure Articulation Test (IPAT).

For nasal airflow data Parkinsonian Diseased (PD) patients were asked to repeat /ʌnʌdʌ/ /ʌnʌnʌ/ and /ʌdʌdʌ/. PD group enhibited nasal airflow during repetition of /ʌdʌdʌ/. They also found that there was increased nasal airflow with an increase in severity of PD which supports the findings that velopharyngeal port function deteriorates with increase in severity of PD. In this study ratings of hypernasality

failed to systematically differentiate between PD and control group, because hypernasality was masked by hoarse, low pitch, breathy voice of PD. Neither did the articulatory measure (IPAT) correlate with the aerodynamic measure (nasal air flow) nor with hypernasality rating.*)*

Eventhough perceptual rating systems such as that developed by Darley et al. (1969) provide rating scales on different speech attributes, strict criteria are yet to be evolved to use such rating scales reliably.

Perceptual rating also depends on the judging formants for determining the intelligibility of speech. Yorkston, Beukelman and Traynor (1988) administered an articulatory inventory on 19 dysarthric adults and judgements of articulatory accuracy was based on two judging formants (1) phoneme identification format where judges are not given information about the identity of the target phoneme. (2) Traditional testing format where judges knew the identity of the target phoneme. Results of this investigation suggested that overall scores on an articulatory inventory are affected by judging format. Traditional testing format consistently resulted in scores that over-estimated the ability of listeners to identify the correct phoneme.

Zyski and Weisiger (1987) investigated the degree of accuracy with which the different types of dysarthrics can be identified by perceptual analysis alone. Speech sample of 7 types of dysarthria had a portion of 'my grandfather' passage and repetitions of the syllables /p^/, /t^/ and /k^/. 16 dimensions of speech to which the samples were compared were:

Overall pitch level

Mono loudness

Excess loudness variation

Breathy voice

Strained / Strangled voice

Hypernasality

Irregular articulation

Vowel distortions

Rate

Phrases short

Reduced stress

Variable rate

Intervals prolonged

Inappropriate silences

Short rushes of speech

Excess and equal stress

Three groups of listeners were considered for perceptual judgements of which two groups were experienced Speech Pathologists and the third group was Speech and Language Pathology Graduates. Results showed that overall accuracy by all groups was low by means of perceptual analysis alone. In-spite of the many disadvantages of perceptual analysis, it is still being used as important measurement tool.

Perceptual assessment requires minimum number of instruments and the perceptual analysis identifies the speech deviances which are contributory to the speech intelligibility of dysarthric speakers in the natural day-day life.

ACOUSTIC ANALYSIS OF SPEECH:

Instrumental acoustic analysis promises to provide more detailed and more distinctive details. Further, acoustic analysis represents the least expensive and least intensive instrumental approach for the evaluation of dysarthria. It also provides detailed information on the disordered behaviour. Canter (1963) investigated objectively certain vocal intensity, pitch and duration characteristics of speech of patients with Parkinson's Disease. 17 ambulatory males with clinical Parkinsonian Disease were considered. Age matched normal subjects were also taken to distinguish speech changes related to

the neurological disease and those due to normal aging process. The subjects were asked to read the first paragraph of 'Rainbow Passage'. Rate of speech was determined by the total length of time required by the subject to read the whole passage. For pitch measurements, the speech sample was fed to the direct writing oscillography. Intensity measures were obtained by playing the recorded sample into a high speed level recorder. The difference between strongest and weakest intensity peak was a measure for intensity variability. It was found that there was reduced intensity and pitch variability in parkinson patients which was responsible for monotony of their speech and they also spoke at significantly higher pitch levels. The normal and experimental group did not differ systematically in terms of rate of speech./

Metter and Hanson (1986) studied the acoustic and clinical variability in hypokinetic dysarthrias. Acoustic speech measurements included

Speaking rate

Mean fundamental frequency

Relative intensity

Vowel phonation time

The speech sample of 10 parkinson patients included reading aloud The grandfather passage' and maximum sustained phonation of

'ah'. The recordings were analyzed using a microprocessor speech analyzer (PM 301, Voice Identification Inc.) The overall intelligibility was rated based on 7 point scale. Variations in the acoustic measurement were studied in dysarthrics with different degrees of severity. Clinical severity of Parkinsonism was evaluated using the Webster scale. Webster scale is linear with a range of 0 (normal) to 30 (most severe) rating. Results showed that severe dysarthrics had either slow/fast rate, (in contrast to Metter and Hanson 1986, Study) but mild-moderate dysarthrics had relatively normal rate of speech. Mean F0 for the patients was within the normal limits though there was a tendency to increase with increase in severity. However, there was no relationship between vowel phonation time, pause time and severity of dysarthria. It was also found that variation in intensity, fundamental frequency and frequency range varied independent of fast or slow rate. Clinical severity (physical disability) was compared to the severity of dysarthria as judged on dysarthria scale. It was observed that there was no correlation between the two (ie) most severe dysarthrias occurred with both mild and severe parkinsonian disability rating.

(Weiser et al. (1985) also studied the acoustic parameters of parkinsonians and normal geriatric adults. Their study reported the following:

decreased duration of voiced segments

reduced formant frequency execution for consonant to vowel and vowel to vowel segments when compared to neurologically normal geriatric speakers.

Seikel et al. (1990) investigated the relationship between the temporal acoustic parameters of the speech of 15 individuals with Motor Neuron Disease (MND) with that of the progression of the disease and clinicians judgement of dysarthria severity. Speech sample was chosen to elicit six initial (p,t,k,b,d,g) and two final (t,d) consonants in each of the vowel (i,a) contexts. The subjects were asked to read the sentence 'say--again' and the sample was analyzed using broad band spectrograms. Results showed that duration of VOT in voiceless consonants and closure duration increased with increase in the severity of the disease. It was found that prevocalic VOT and pre-vocalic closure duration were strongest predictors of age since outset.

Weismer (1984) found three acoustic correlates of imprecise consonant articulation in PD patients. They were:

Spirantization (Presence of fricative like aperiodic noise during stop closures)

Spectral tilt (Relative distribution of energy in the spectra of stop and fricative consonants)

Timing of vocal onsets and offsets.

He found that these patients produced abnormal amount of spirantization particularly for 'b' consonant and there was abnormal distribution of spectral energy particularly for fricatives at low frequencies. There was also significant amount of voicing duration during voiceless closure interval of voiceless stops.

Kent, Netsell and Abbs (1991) subjected the speech of 5 individuals with cerebellar disease and ataxic dysarthria to acoustic analysis. He asked the subjects to recite six sentences and few bisyllabic and trisyllabic words constructed using a base word (stem). Using these words, vowel formant structure, vowel duration and CV and VC formant transition were investigated. The following parameters were studied - vowel and diphthong duration, VOT, stop gap for different consonants, frication duration and syllable duration. Result of vowel formant frequencies showed that even-though all vowels were judged adequately produced perceptually, most of the syllables of the ataxic subjects appeared lengthened even transition duration was increased. It was also found that most severely involved ataxic

subjects showed significant lengthening of VOT and friction. The least severe ataxic had some durations that approached the group mean value for normals. The differences in total word duration between ataxic and normal subjects were quite large. The ataxic subjects also exhibited inconsistent reductions in syllable duration of the base word as the number of syllables in the words was increased whereas the normals never showed an increase in base word duration between single syllabic and bisyllabic words. High degree of variability of segment duration was observed by these authors.

Hardcastle, Barry and Clark (1985) used instrumental technique of electropalatography (EPG) and pneumotachogrpaphy to examine details of VOT characteristics and tongue palate contacts of dysarthrics and this was compared with that of normals. Details of the location and timing of tongue contacts with the palate were recorded by an EPG. The dysarthrics showed evidence of undershoot of articulatory targets exemplified by the incomplete closure for stops and the reduction of consonant sequences. This undershooting of target articulation arises from insufficient muscular tension in the relevant articulatory muscles. VOT results showed that normal speakers showed clear separation in VOT values of all places of articulation with no overlap in values, whereas in

dysarthrics there was overlap in VOT values for bilabials and little distinction between voiced and voiceless cognates for other places of articulation vowel duration preceding the voiced and voiceless stops was expressed in ratio was less in dysarthrics than in normals indicating that usually vowel duration was less before the voiced stop cognate.

Canter (1965) compared the articulatory DDK performance of 17 Parkinsonian patients with that of normal controls. Study showed that the experimental group showed impaired ability to perform rapid movements. Tongue tip movements were greatly affected. Main attributes to the articulatory problem were imprecise production of plosive consonants, disco-ordination of phonatory and articulatory activity. It was also found that articulatory DDK were correlated with clarity of speech which in turn was correlated with overall speech adequacy. This finding was in contrast to the study of Cooper and Buck (1956) who noted a poor trend toward an association between a poor DDK rate and severe speech involvement. This was studied by comparing tongue tip DDK rates and judgement of articulatory proficiency of 48 parkinsonian patients.

Kruel (1972) contrasted the DDK rates, reading rates and maximum duration of prolonged vowels for 3 groups of speakers-healthy young normal adults, healthy elderly adults and patients of various ages with parkinsonism . Subjects were asked to sustain 3 vowels - /a/ /i/ /u/ as long as possible in a single breath. 5 DDK movements /t^/ /p^/ /k^/, /i/ interrupted and vowel transition from /u/ to /\/ were considered. Reading rate was measured for a 300 words passage at a normal and accelerated rates. Results showed that the reduced ability to prolong a vowel sound was associated with both age and parkinsonism. Duration of vowel prolongation was less in elderly normal subjects and in parkinsonon subjects. Decrease in parkinsonism can be due to both the neurological disturbance and aging process. Syllable rate for /p^/ /t^/ and /k^/ was same for all the three groups but repetition of /\/ interrupted was decreased in parkinsonics but was same in both young and elderly normal adults. This indicated that in parkinsonian subjects discrete control of larynx is affected. Results of reading rate indicates that the younger group have faster reading rate and parkinsonic patients had reduced reading rate.

Ludlow and Barsich (1983) analyzed the speech of two dysarthrics based on acoustic and perceptual aspects and compared them with that of normals. Speech sample of each subject included the

extended phonation of the vowels /a/ and *lil,* initiation of the same sentence at regular and fast rates, rapid repetition for 10 seconds. The vowels /a/ *lil lul* /ua/ /pa/ /ta/ /ka/ /pate/ and /paka/. Initiation of a low to high pitch on the vowel /a/ and the word /no/ at 4 loudness levels. 19 different speech attributes reported to be impaired in hypokinetic dysarthrics by Darley et al (1975) were selected for this study. Both the acoustic and perceptual assessment systems were capable of discriminating accurately between the 2 types of dysarthria. Differences in rate control, variation in loudness and fundamental frequency and reduced stress variations were identified in both systems. The acoustic system identified vowel voicing errors as particularly important while voice quality and overall rate were important for perceptual assessment to identify differences in types of dysarthria. The perceptual rating system identified breathiness, wet hoarseness and strained strangled voice as useful for identifying the types of dysarthria.

Forrest, Weismer and Turner (1989) conducted acoustic, perceptual and kinematic analysis of speech of 9 parkinsonians and compared it with the normal geriatrics. Kinematic analysis showed that the experimental group had limited jaw movements compared to normals. For opening gestures, jaw displacement and velocities produced by parkinsonian subjects were about 1/2 of those produced

by normal geriatrics. Lower lip movement amplitude and velocity was recorded in PD subjects relative to normal geriatrics and the velocity of lower lip movement decreased with severity.) Acoustically, the PD subjects had reduced duration of vocalic segments, reduced 1, 2 formant transitions and increased VOT as compared to normal geriatrics. And it was found that the effects were greater for the more severe compared to milder dysarthrics and were most apparent in the more complex vocalic gestures.)

Kent et al. (1992) studied the speech intelligibility and its phonetic and acoustic correlates in a group of 10 Amytrophic Lateral Sclerosis (ALS) females. ALS subjects were recorded on audio tape while reading aloud test word from cards. 19 phonetic contrasts that were tested were:

Front-back for vowels

High/low for vowels

Vowel duration

Voicing contrast-initial consonant

Voicing contrast - final consonant

Alveolar Vs palatal consonant

Place of articulation for stop consonants

Place of articulations for fricatives

Fricative - affricative

Stop - fricative

Stop - affricative articulation

Stop-nasal articulation

Syllable-initial */h/* Vs syllable initial consonant

Presence / absence of syllable final consonant

Initial consonant Vs consonant cluster

Final consonant Vs consonant cluster

/r/ Vs /l/

/r/ Vs /w/

Listeners were given a response form that had 4 words in each numbered row, one target word item and three alternative foils. Each target word and foil pair differed by 1 or 2 contrasts. Identification measure was obtained by word identification test with multiple choice by 10 listeners. Phonetic contrasts that were most severely affected was found to be stop Vs nasal followed by alveoli Vs palatal consonant, presence or absence of syllable final consonant, initial consonant Vs initial cluster and stop Vs affricate articulation. Acoustic measure for sustained vowel prolongation revealed abnormalities in fundamental frequency, Jitter and shimmer and S/N ratio. Acoustic measure of F_1 and F_2 trajectory for words

showed longer duration (indicating slow rate) shallower in slope (decreased rate of articulatory movement) and more variable (reflecting differences in severity).

Review of literature reveals that there are few parameters of speech which changes with aging process. Among these geriatric voice changes are studied in abundant. Sparse research has been done in terms of other parameters in geriatrics. It has also been found that many speech characteristics in geriatrics overlap with that of dysarthrics speech characteristics.

METHODOLOGY

Review of literature shows that several changes takes place in the speech of an individual due to normal aging. (Ptacek et al 1966, Ryan and Burk 1974, Smith et al.1987, Parnell and Amerman 1987, Hoit et al 1993). In general degenerative changes including speech is reported to occur in normals after their forties. (Brizzee, 1975). Dysarthria in adults usually occurs in late forties and fifties. In these dysarthrics then, the influence of aging over the speech symptoms needs to be ascertained.

!t is possible that a few of the speech symptoms could be due to complimentary influence of dysarthria and/or aging. Identification of such influences has an important bearing in the diagnostic considerations in dysarthrics.

This study attempted to identify the features which were shared and/or exclusive to dysarthria and aging process. The aged geriatric normal individuals in this study was defined as those individuals above 40 years of age where age related changes starts appearing.

OBJECTIVES:

The main objectives of this study were:

a) To perceptually and acoustically analyze the words consisting of /k/ and /g/ phonemes combined with different vowels in various CV combinations uttered by dysarthric and the normal geriatric subjects.

b) To study the features which were exclusive in dysarthrics and normal geriatrics.

c) To study the features which overlapped in the dysarthrics and normal geriatrics.

This was carried out by comparing the speech of two group of subjects - dysarthrics and normal geriatrics on various parameters.

HYPOTHESIS:

1. There are no perceptual features in the speech of normal geriatrics and dysarthrics which overlap
2. There are no acoustic features in the speech of normal geriatrics and dysarthrics which overlap

METHOD:

A. SUBJECTS:

Two groups of subjects were taken. First group consisted of 10 normal geriatrics. As age related changes starts by 40 years, the age range of this group was 40-85 years. Second group consisted of 10 dysarthrics, of either mild, moderate or severe category. The severity and type was determined by clinical appraisal and by using the scale FDA (Frenchay Dysarthria Assessment) developed by Enderby in 1980. Subjects of first group were age matched with that of the second group. Both the groups were further divided based on their age. The cut-off criteria was 60 years.

B. CRITERIA FOR SELECTION OF SUBJECTS:

(i) Selection Criteria for dysarthrics:

(a) Only those dysarthric subjects with confirmed medical diagnosis regarding the type of dysarthria were chosen.

(b) Age of the subject was within 40-85 years. This age range was selected in order to observe if symptoms due to normal pathologies superimposed with that of normal aging.

(c) The subjects were able to speak the standard dialect of Kannada with a minimum mean length of utterance of 2-3 words.

(d) Subjects who had not undergone speech therapy / or subjects who had attended speech therapy for less than 2 months were considered

(e) Dysarthrics with associated problems such as language impairment, dementia, overlapping psychological problems and significant hearing loss were not considered.

(ii) Selection criteria for normal geriatrics:

(a) Subjects who were clinically free from neurological problems and who had no hearing, speech and language problems as assessed by Speech, Language Pathologists were considered as 'normal' subjects.

(b) Normal geriatrics between the age group of 40-85 years, whose age and sex were matched with that of dysarthrics were considered

C. DEVELOPMENT OF TEST MATERIAL:

Two consonants /k/ and /g/ were selected. These consonants were combined with the vowels (both short and long vowels) and words were constructed in Kannada such that the consonants occurred in all the three positions initial, medial and final. In total there were 48 stimulus words in this study. **(See APPENDIX I).**

D. RECORDING OF THE SPEECH SAMPLE:

The 48 stimulus words were given to a normal female adult with no speech and hearing problem. The adult was asked to read the words and this was recorded on Ahuja Stereo cassette recorder 4040S with unidirectional dynamic microphone. The normal geriatric and dysarthric subjects were asked to listen to this model words and repeat them one after the other. This was carried out individually for each subject. Between two test words a gap of 10 seconds was given. An audio signal was given to the subjects before the presentation of each test word of the model. Audio recording of the subjects was carried out in a sound treated room.

The subjects' task was to repeat the words of the model one by one which was played on the tape recorder. The subjects

were instructed to repeat the words as naturally as possible with a normal rate and prosody.

The audio recording was carried out using Ahuja Stereo Cassette Recorder 4040 S with a unidirectional dynamic microphone kept at less than 7-8 inches from the speakers' mouth. The VU meter gain was maintained at an optimum level during the recording. One Practice trial with 5 words were provided for each subject before recording the stimulus words.

E. ANALYSIS OF THE SAMPLE :

Two types of analysis were carried out in this study

Perceptual analysis and

Acoustic Analysis

Perceptual Analysis:

The recorded words of the normal geriatric and dysarthric speakers were subjected to perceptual judgement. One Speech and Language Pathologist who was a post graduate with more than 5 years of working experience with the dysarthrics was selected for the same. The recorded speech of

dysarthrics and normal geriatrics were randomized and played to the judge in a sound treated room.

Judge was instructed to listen to the words and rate the sample on a 31 speech dimensions(adopted from Darley et al. 1966 and Ingram et al. 1988) (see Appendix -II) using a 5 point rating scale. To make the task easier for the judge, each word was repeated twice. As the perceptual speech dimensions of Darley etals' (1966) study and Ingram et. al (1988) were for sentences, those only parameters that were appropriate for the perception of words were selected and adopted for this study.

Acoustic Analysis:

The words uttered by normal geriatrics and dysarthric subjects were subjected to acoustic analysis. To carryout acoustic analysis the recorded speech was digitized using the Speech Interface Unit (SIU) using the line feed method. The signal from SIU was digitized at a sampling rate of 16000 Hz using a 12 bit analogue to digital (A-D) and Digital to Analogue (D-A) converter housed within the computer. The digitized signals were stored on the hard disk of the computer with individual file names for each words. Using SSL program of **"VAGHM"**

software package of Voice and Speech System (VSS) each word was analyzed for the following parameters - Preceding Vowel Duration, Syllable Duration, Following Vowel Duration, VOT, Closure Duration, Transition Duration and Speed of Transition.

Description of the Parameters:

1. Voice Onset Time (VOT):

VOT was defined as the time equivalent space from the onset of the stop release burst to the first vertical striation representing glottal pulsing. (Lisker and Abramson, 1964,)

VOT was measured for voiced consonant /g/ and for voiceless consonant /k/ in the target words from the waveform. The cursor was moved to the first indication of energy associated with the stop oral release and later the cursor was moved to the beginning of the regularly appearing waveform of the vowel following that stop. The real time value (in millisec) between the two markings provided the VOT for particular consonant.

2. Vowel Duration (VD):

This was defined as the time in millisecond between the onset and offset of the vowel within a word. A vowel before the consonants k/g is proceeding vowel and its duration is Proceeding Vowel Duration (PVD) and the duration of the vowel following the consonants k/g is the Following Vowel Duration (FVD). The vowels were identified based on the regularity of the waveform and vertical striations.

The vowel duration was considered to extend from the beginning of one periodic signal to the end of the periodicity.

Preceeding vowel duration was absent in those words where the consonants /k/ and /g/ occurred in the initial position. The duration was highlighted for each word using the cursors and the highlighted portion was played back through headphones, to confirm that it contained the vowel. Once this was confirmed, the duration of the highlighted portion was read from the display

3. Closure Duration (CD):

Closure duration was defined as the time in milli-second from the offset of vocal fold vibration to the onset of burst. This was

measured by moving the cursor from the point where the striation starts fading away to the point of outset of sudden noise burst. Closure duration is absent in those words which has the target consonants /k/ and /g/ in the initial position.

4. Syllable Duration (SYLL. DUR):

Syllable duration is the time taken between the initiation and termination of target syllable.

This duration was highlighted through the use of cursors. The highlighted portion was played back through the headphones to confirm that it contained the syllable under study. Once this was confirmed, the duration of the highlighted portion was read from the display and this was considered as syllable duration.

5. Burst Duration (BD):

Burst duration was defined as the time in milliseconds between the onset of sudden noise burst till the offset of **a** stop consonant either /k/ or /g/.

6. Transition Duration (TD):

Transition duration is defined in milliseconds as the time taken for the F_2, following the stop burst to reach the steady state of the adjacent vowel segment. The cursor was moved from the point of burst to the point where the adjacent, vowel reached its steady state to calculate Transition Duration which was read on the display.

7. **Speed Of Transition (ST):**

The speed of transition was defined as the ratio of the values obtained for the extent of formant transition by the values obtained for the formant transition duration..

Statistical Analysis

5-way ANOVA was used to study whether there was any significant difference between the two groups i.e. dysarthrics and normal geriatrics, in term of the objectives of the study.

RESULTS AND DISCUSSION

The aim of the study was to analyze the acoustic and perceptual features in the speech of the normal geriatric and adult dysarthrics.

The speech sample of the ten adult dysarthrics (aged 40-85 years) and ten age matched normal geriatrics initiating 48 Kannada words were subjected to acoustic and perceptual analysis. The 48 words consisted of either /k/ or /g/ in combination with short and long vowels in three positions. (Initial, Medial and Final.)

Objectives of the study were:

- To perceptually and acoustically analyze the words uttered by the normal geriatrics and dysarthrics.

- To study the speech parameters which were exclusive and/or overlapping in dysarthrics and normal geriatrics.

The results are discussed under two main sections:

I. Acoustic Analysis

II. Perceptual Analysis

I. ACOUSTIC ANALYSIS:

Using SSL program of "VAGHMI" software package of voice and speech system (VSS) the following parameters were analyzed:

- Preceding Vowel Duration
- Following Vowel Duration
- Closure Duration
- Burst Duration
- VOT
- Syllable Duration
- Transition Duration
- Speed of Transition

A repeated measures (5x5) analysis of variance (5 way ANOVA) was performed to find statistically significant differences between the normal geriatric group and dysarthric group. The five factors considered are :

1. Group Type:

Two groups studied were normal geriatrics and dysarthrics

2. Age Type:

The two groups were further divided into two based in their age

Group (i) below 60 years of age

Group (ii) above 60 years of age

3. Consonant Type:

Consonants taken up were :

Voiced velar consonant /g/

Voiceless velar consonant /k/

4. Vowel Type:

Vowels with which the phonemes /k/ and /g/ were combined in the words are classified as:

Short vowels (a,i,u,e,o)

Long vowels (a:, i:, u:, e:, o:)

5. Position Type : The position of the phonemes /k/or /g/ in the words. Three positions considered are :

Initial Position

Medial Position

Final Position

Level of significance which was considered to decide whether the normal geriatrics group was significantly different from the dysarthrics group was 0.05 level "Post-hoc test" was used when 'position type' was a factor which contributed for the significant

difference between the normal geriatrics group and dysarthric group to determine the position type (Initial, medial or final position) responsible for the significance.

1. PRECEEDING VOWEL DURATION (PVD):

Preceeding vowel duration is the duration of the vowel preceeding the phonemes /k/ or /g/.

PVD is calculated only for those words where /k/ or /g/ appeared in the medial or final position. The mean PVD for different variables and for normals and dysarthrics are represented in TABLE 1 (a).

TABLE 1 (a) : Mean PVD (in millisecs) for different factors

(in millisecs)

GROUP	MEAN	AGE		CONSO-NANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60	/g/	/k/	Short	Long	Initial	Medial	Final
NORMALS	151	154	243	160	138	165	130	-	138	213
DYSARTH-RICS	237	149	232	248	280	246	224		229	275

From table 1(a) the following points are to be noted:

The mean preceding vowel duration in normals is 151 millisecs and in dysarthrics it is 237 millisecs.

In normals below 60 years, mean PVD has been found to be 154 milliseconds and in dysarthrics below 60 years if is 149 milliseconds. In normals above 60 years mean PVD is 243 milliseconds and 232 millisecs in dysarthrics above 60 years.

When consonant type is considered, vowel duration preceeding /g/ is 160 millisecs in normals and 248 ms for dysarthrics. Vowel duration preceeding /g/ in normals is 138 millisecs and in dysarthrics it is 220 millisecs.

In normals, preceeding vowel duration for short vowels is 165 millisecs and for dysarthrics it is 246 millisecs. For long vowels, preceeding vowel duration i.e. 130 millisecs in normals and 234 millisecs in dysarthrics.

TABLE 1(b) : Level of significance for various factors

PVD	
FACTORS	SIGNIFICANCE
GROUP	.000
AGE	.398
CONSONANT	.389
VOWEL	.212
POSITION	.001

Table 1 (b) shows the significant ratios for the different factors 5 ways ANOVA is used to find the significance at 0.05 level.

Table 1(a) & (b) shows the following:

(i) There is a significant different in the PVDs between the normal geriatric group and dysarthric group. In general, it is seen than mean PVD for /g/ is higher than the mean PVD for /k/ in normals and dysarthrics. This is in agreement with several other studies (House and Fairbanks (1953), Denes (1955), Peterson and Lehiste (1960), House (1961) and Savithri (1989) where it has been found than the vowels before the voiced consonants are longer than the vowels before the voiceless consonants . But this has not been found to produce statistically significant difference.

(ii) However, when /k/ and /g/ occurred in medial and final positions of words there has been a significant difference in PVD in both normals and dysarthric groups as evidenced in Table 1(b). The difference in PVD for the medial and final position consonants between the normal geriatric group and dysarthric group suggests that towards the end of the word, duration increases. This

increase is much higher in dysarthric group due to overall slow transition of the articulatory gestures.

2. FOLLOWING VOWEL DURATION (FVD):

Duration of the vowel following the key phonemes /k/ or /g/. Using 5 way ANOVA mean FVD for the different factors has been calculated and is summarized in Table 2 (a).

TABLE 2(a): Mean FVD (In millisecs)for different factors

(in millisecs)

GROUP	MEAN	AGE		CONSO-NANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60	/Q/	/k/	Short	Long	Initial	Medial	Final
NORMALS	176	181	172	186	164	128	233	182	159	227
DYSARTH-RICS	226	261	219	245	225	188	294	232	227	302

Table 2 (a) shows the mean value for FVD in normals and dysarthrics for various Factors. Table 2 (a) indicates the following:

Mean FVD for normals is 176 millisecs and for dysarthrics it is 226 millisecs.

For normals below 60 years, mean FVD is found to be 181 millisecs and for dysarthrics below 60 years it is 261 millisecs. For normals above 60 years, mean FVD is 172

millisecs and for dysarthrics above 60 years it is 219 millisecs.

With respect to the consonant type, vowel duration following /g/ is 186 millisecs in normals and 245 millisecs in dysarthrics. Following vowel duration for /k/ in normals is 164 millisecs and 225 millisecs in dysarthrics.

Following vowel duration for short vowels in normals is 128 millisecs and for dysarthrics it is 188 millisecs. For long vowels in normals FVD is 233 millisecs and for dysarthrics it is 294 millisecs.

Vowel duration following the consonants */k/* or /g/ when they are occurring in initial position is 182 millisecs in normals and 232 millisecs in dysarthrics. When the consonant is in the medial position the FVD in normals is 159 millisecs and for dysarthrics it is 227 millisecs. When the consonant is in the final position FVD in normals is 227 millisecs and it is 302 millisecs for dysarthrics.

TABLE 2(b) : Level of significance for various factors

	PVD	
FACTORS		SIGNIFICANCE
GROUP		.000
AGE		.000
CONSONANT		.018
VOWEL		.000
POSITION		.000

Using (5x5) way of analysis (ANOVA) the significance ratios at 0.05 level for each of the 5 factors is determined and it is depicted in Table 2(b).

(i) From the results it is noted that mean FVD in dysarthrics is more than the mean FVD in normals. This difference is significant between the normals and dysarthrics.

(ii) Vowel duration following voiced consonant /g/ is found to be increased when compared to the vowel duration following voiceless consonant /k/. This is found to be significantly different both in normal group and dysarthric group.

(iii) In both normals and dysarthrics, duration of long vowels is found to be more than the duration of short vowels. This is found to be significantly different in both the groups of normals and dysarthrics. This is in agreement with the results obtained in several Indian studies by Velayudhan (1975) Savithri (1989), Reddy (1988) and Venkatesh (1995).

(iv) There is significant different in the mean FVD of normals below 60 years and above 60 years. Likewise there is a significant difference in the mean FVDs of dysarthrics below 60 years and above 60 years.

The increased following vowel duration in dysarthrics can be considered to Contribute for the slow rate of speech production. It has been found in the perceptual analysis of this study and also on observation by Darley et al. (1969). Slow rate of articulation has also been reported in normal geriatrics by Ryan and Bulk (1974)

(v) When a parameter has more than two factors post hoc test is used to find out which among the three factors

contribute for the difference. As position of occurance of /k/ and /g/ in initial, medial and final position in a word is a factor, post hoc test has been used to find the influence of position type, (initial, medial or final). It is found that between the initial final and medial final positions of /k/ and /g/ there is a significant different in normal geriatric group and dysarthric group.

3. CLOSURE DURATION (CD):

Closure duration is the interval of stop closure indicating the time for which the articulators are held in position for a stop consonant. Closure duration is calculated only in those words where the phonemes /k/ or /g/ has occurred in medial or in final position.

TABLE 3 (A): Mean closure duration in millisecs for various factors in normals and dysarthrics.

(in millisecs)

GROUPS	MEAN	AGE		CONSONANT TYPE		POSITION TYPE	
		< 60	> 60	/g/	/k/	medial	Final
NORMALS	60	68	55	44	76	58	66
DYSARTH -RICS	79	98	64	64	90	79	79

Table 3(a) shows the mean closure duration (in millisecs) in normals and dysarthrics for various factors. Observation of the table 3(a) suggests the following:

Mean closure duration in normals is 60 millisecs and in dysarthrics it is 79 millisecs.

It is also found that in normals below 60 years CD is 68 millisecs and the mean closure duration in normals above 60 years is 55 millisecs. In dysarthrics below 60 years the mean closure duration is 95 millisecs and above 60 years it is 64 millisecs.

Closure duration for /g/ in normals is 44 millisecs and in dysarthrics it is 64 millisecs. In normals, closure duration for /k/ is 76 millisecs and for dysarthrics it is 90 millisecs.

When the consonants occurred in medial position the mean value of closure duration is 58 millisecs for normals and 79 millisecs for dysarthrics. Mean closure duration for consonants occurring in final position in 66 millisecs for normals and 79 millisecs for dysarthric group.

TABLE 3 (B): Level of Significant for various factors

FACTORS	SIGNIFICANCE
GROUP	.000
AGE	.000
CONSONANT	.000
POSITION	.292

Table 3(b) shows the level of significance ratios for the various factors for closure duration.

From the result it is noted that—

(i) Closure duration in dysarthric group is found to be increased which is found to contribute for the significant difference between the normal geriatric group and dysarthric group. This is in agreement with the study by Seikel et al. (1990). Increased CD. in dysarthric group can be attributed to incomplete closure due to which longer duration is required to build the intra -oral pressure for the production of consonants . Reason for incomplete closure according to Hardcastle et al. (1985) is due to undershooting of articulatory target arising from insufficient muscle tension. In some severe dysarthrics it has been found that the transition from

one speech segment to another is continuous resulting in absence of closure duration.

(ii) Closure duration for voiced consonant is less when compared to that of voiceless consonant and this difference is to be significant in both normals and dysarthrics. This is in agreement with the studies by l_isker(1967) and Savithri(1978).

(iii) It has been found that closure duration is significantly higher in lower age group (below 60 years) of normals and dysarthrics compared to higher age groups(above 60 years). This is contrary to the indications in the literature by Pitangry (1978) where closure duration is reportedly increased in aged group as the muscle tension in individuals above 50 years decreases.

4 BURST DURATION (BD):

Burst duration is the time interval between the onset and offset of the burst.

TABLE 4(A): Mean Burst Duration in millisecs of normals and dysarthrics for various factors.

(in millisecs)

GROUPS	MEAN	AGE		CONSO-NANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60	/g/	/k/	Short	Long	Initial	Medial	Final
NORMALS	10	10	10	9	11	10	10	10	10	10
DYSARTH-RICS	15	13	17	15	17	15	16	16	15	11

The mean burst duration for normals and dysarthrics for various factors is depicted in Table 4(a). The results are as follows:

The mean burst duration for normals is 10 millisecs and for dysarthrics it is 15 millisecs.

For normals below 60 years, the mean burst duration is 10 millisecs and for dysarthrics below 60 years it is 13 millisecs. Mean burst duration for normals above 60 years is 10 millisecs and for dysarthrics above 60 years it is 17 millisecs.

For the consonant /k/ burst duration in normals is 11 millisecs and for dysarthrics it is 17 millisecs. For the consonant /g/

burst duration is 9 millisecs for normals and 15 millisecs for dysarthrics.

Burst duration in normals is 10 millisecs irrespective of whether the vowel following the consonant is short or long. But in dysarthrics; the mean burst duration is 15 millisecs for consonants followed by short vowels and 16 millisecs for consonants followed by long vowels.

Irrespective of the position of the consonant in a word mean burst duration has been found to be 10 millisecs in normals. In dysarthrics, mean burst duration for consonants in initial position is 16 millisecs, for medial position it is 15 millisecs and for final position it is 11 millisecs.

TABLE 4(b): Level of Significance for various factors

FACTORS	SIGNIFICANCE
GROUP	.000
AGE	.023
CONSONANT	.482
VOWEL	.889
POSITION	.360

The significance ratios for various factors was determined by 5 way **ANOVA.** The results indicate that -

(i) Burst duration was increased in dysarthrics when compared to normal geriatrics which yielded a significant difference between the two groups. Qualitative judgement shows that there are several bursts, which might have contributed for increased burst duration. In severe dysarthrics burst was absent due to incomplete closure and continuous transition from one speech segment to another.

(ii) There is a significant difference in the mean BD of normals below 60 years and above 60 years. Likewise there is a significant difference in the mean BD of dysarthrics below 60 years and above 60 years.

5. VOICE ONSET TIME (VOT):

VOT has been defined as the time interval between the release of the burst and the onset of voicing.

VOT for voiced stop is lead VOT as voicing onset is briefly preceeding the stop release.(Kent and Read,1995) For voiceless stops. VOT is lead VOT since during the production of voiceless

stops, voicing starts when a transglottal pressure drop sufficient to voicing is developed after the release burst. (Mueller and Brown, 1980).

TABLE 5(a) : Mean VOT (in millisecs) of normals and dysarthrics for various factors

(in millisecs)

GROUP	MEAN	AGE		CONSO-NANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60	/g/	/k/	Short	Long	Initial	Medial	Final
NORMALS	-10	-9	-10	-44	27	-13	-6	-8	-4	-45
DYSARTH-RICS	-3	-7	-5	-58	38	-4	-1	-4	-4	-50

As seen all the VOT values are reduced as lead and lag VOT have been combined together while comparing normal geriatrics and dysarthrics except when consonant type is considered.

The mean VOT of normals; and dysarthrics for various factors are as follows:

Mean VOT of normals is -10 millisecs and for dysarthrics it is -3 millisecs.

In normals below 60 years of age mean VOT is -9 millisecs and in normals above 60 years of age mean VOT is -10 millisecs. In dysarthrics below 60 years mean VOT is -7 millisecs and it is -5 millisecs for dysarthrics above 60 years.

For voiced consonant /g/ mean VOT in normals is -44 millisecs and for dysarthrics it is -58 millisecs.. In normals for voiceless consonants /k/ mean VOT is -27 millisecs and it is 38 millisecs in dysarthrics.

Mean VOT of normals for consonants followed by short vowel is -13 millisecs and for dysarthrics VOT is -4 millisecs. In normals, mean VOT for consonants followed by long vowel is -6 millisecs and it is -1 millisecs in dysarthrics.

In initial position, mean VOT of normals is -8 millisecs and it is -4 millisecs for dysarthrics. For medial and final position consonants, mean VOT in normals is -4 millisecs and -45 millisecs respectively. In dysarthrics mean VOT for consonants in medial position is -4 millisecs and it is -50 millisecs in dysarthrics for final consonants.

TABLE 5(b): Level of Significance ratio for various factors

FACTORS	SIGNIFICANCE
GROUP	.726
AGE	.666
CONSONANT	.000
VOWEL	.556
POSITION	.765

Using 5 way ANOVA the factors contributing for the significant difference between the normal geriatrics and dysarthric group has been determined and it is depicted in Table 5(b).

The results indicates that —

(i) VOT for voiceless is found to be increased when compared to that of voiced consonants irrespective of the group. This is a significant factor, which contributes to the significant difference between the normal group and dysarthric group. This indicates that there is clear cut distinction between the VOTs of voiced and voiceless. But the results of the study by Hardcastle et al. (1985) is contradicting where they have found that dysarthrics showed little distinction between voiced and voiceless cognates.

(ii) In general, the mean VOT in dysarthrics is increased than the mean VOT of normals. This is in agreement with several studies (Seikel 1990, Kent et al. 1991)

6. SYLLABLE DURATION (SD):

Syllable duration is the duration of the key phonemes /k/ or /g/ when it is combined with vowels.

TABLE 6 (a): Mean Syllable duration of normals and dysarthrics for various factors

(in millisecs)

GROUP	MEAN	AGE		CONSONANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60	/g/	/k/	Short	Long	Initial	Medial	Final
NORMALS	239	258	226	245	231	195	291	222	236	339
DYSARTH-RICS	295	324	245	292	279	245	355	270	310	350

From Table 6(a) which shows the mean syllable duration for various factors, the following points are noted :

Mean syllable duration of normals is 239 millisecs and for dysarthrics it is 295 millisecs.

For normals less than 60 years, mean syllable duration is 258 millisecs and for dysarthrics below 60 years it is 324 millisecs. Mean syllable duration for normals above 60 years is 226 millisecs and below 60 years it is 275 millisecs.

Mean syllable duration for (g) in normals is 245 millisecs and in dysarthrics it is 292 millisecs. For consonants /k/ in normals mean syllable duration is 231 millisecs and in dysarthrics mean syllable duration is 299 millisecs.

When the consonants are combined with short vowels, the syllable duration in normals is 195 millisecs and in dysarthrics it is 245 millisecs. In normals, mean syllable duration is 291 millisecs when the consonants are combined with long vowel and it is 355 millisecs in dysarthrics.

When consonants are in initial position the mean syllable duration is 222 millisecs in normals and 270 millisecs in dysarthrics. It is found to be 236 millisecs in normals when the consonants are in medial position and it is 310 millisecs in dysarthrics. For consonants in final position the mean syllable duration is 339 millisecs in normals and 350 millisecs in dysarthrics.

TABLE 6(b): Level of significance for various factors

FACTORS	SIG.
GROUP	.000
AGE	.000
CONSONANT VOWEL	.202 .000
POSITION	.000

Table 6(b) shows the significant ratio for various factors determined by 5 way ANOVA.

The results indicates the following:

(i) In dysarthric group. Syllable duration is increased than the normals. This is a significant factor, which contributes for the significant difference between the normal geriatric group and dysarthric group. Similar results of increased syllable duration were found by Parnell and Amerman (1987) and Kent et al. (1991). This increased syllable duration is attributed to the slow rate of speech production and this is perceptually evident by the dragging effect in the speech of the dysarthrics.

(ii) In normals, the syllable duration of */k/* or /g/ when combined with long vowels is more than that with short vowels. This is due to the increased duration of long vowels, which is twice the duration of short vowels. (Savithri, 1978). In the same manner, syllable duration of the phonemes /k/ or /g/ is increased when combined with long vowels. This is a significant factor to significantly differentiate between the normal group and dysarthric group.

(iii) There is a significant difference in the mean syllable duration of normals below 60 years and above 60 years. Likewise there is a significant difference in the mean syllable duration of dysarthrics below 60 years and above 60 years.

(iv) When the consonants are occurring in various positions of a word, the mean syllable duration of dysarthrics is found to be significantly different from the mean syllable duration of normals.

7 TRANSITION DURATION (TD):

It is defined as the time taken for the F_2 following the stop burst to read the steady state of the adjacent vowel.

TABLE 7(a): Mean Transition Duration of normals and dysarthrics for various factors

(in millisecs)

GROUP	MEAN	AGE		CONSO-NANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60	/g/	/W/	Short	Long	Initial	Medial	Final
NORMALS	30	32	29	31	30	27	35	29	31	35
DYSARTH-RICS	41	45	39	40	43	37	46	42	41	40

Table 7(a) shows the mean Transition Duration of normals and dysarthrics for various factors:

Mean Transition Duration in normals is 30 millisecs and 4 millisecs for dysarthrics.

-In normals below 60 years mean transition duration is 32 millisecs and in dysarthrics below 60 years it is 45 millisecs. Mean Transition Duration of normals above 60

years is 29 millisecs and in dysarthrics above 60 years it is 39 millisecs.

Mean Transition Duration for /g/ is 31 millisecs in normals and 40 millisecs in dysarthrics. For the consonant /k/ in normals transition duration is 30 millisecs and in dysarthrics it is 43 millisecs.

Transition Duration for consonants with short vowel in normals is 27 millisecs and 37 millisecs in dysarthrics. In normals Transition Duration for consonants with long vowels is 35 millisecs and it is 46 millisecs in dysarthrics.

Mean Transition Duration for initial, medial and final position consonants for dysarthrics is 29,31 and 35 millisecs respectively. For dysarthrics, mean Transition Duration for initial position consonant is 42 millisecs, 41 millisecs for medial position consonants and 40 millisecs for final position consonants.

TABLE 7(b): Level of significance for various factors.

FACTORS	SIGNIFICANCE
GROUP	.000
AGE	.004
CONSONANT	.242
VOWEL	.000
POSH ION	.016

Using 5 way ANOVA the factors which results in significant difference between the normal geriatrics and dysarthrics has been analyzed.

The results are as follows:

(i) Mean transition duration is increased for dysarthric group when compared to normal geriatric. This difference is significant between the normal geriatric group and dysarthric group. This is in agreement to the study of Kent et al. (1991). This increase in transition duration is attributed to the slow articulatory movement change from one position to another.

(ii) There is a significant difference in the mean Transition Duration of normals below 60 years and above 60 years.

Likewise, there is a significant difference in the mean TD of dysarthrics below 60 years and above 60 years.

(iii) There is a significant difference in mean transition duration of the short and long vowel for normals and dysarthrics.

(iv) When a parameter has more than two factors, post hoc is used to find out which among the three factors contributes for the difference. As position of occurrence of /k/ and /g/ in initial, medial and final position of a word is a factor post hoc list has been used to find the influence of position type (initial, medial or final). It is found that initial-medial, initial-final positions of /k/ and /g/ there is a significant difference between the normal geriatric group and dysarthric group.

8. SPEED OF TRANSITION (ST):

Speed of Transition is the ratio of extent of formant transition by the transition duration.

TABLE 8(a): Mean of speed of Transition (in Hz /millisecs) in normals and dysarthrics for various factors.

(in millisecs)

GROUP	MEAN	AGE		CONSO-NANT TYPE		VOWEL TYPE		POSITION TYPE		
		< 60	> 60		/k/	Short	Long	Initial	Medial	Final
NORMALS	5	4	5	5	4	5	4	5	4	4
DYSARTH-RICS	4	4	4	4	5	6	4	5	4	2

Table 8(a) shows the mean of speed of transition of normals and dysarthrics for various factors. The table suggests that:

Mean of speed of transition in normals is 5 Hz/millisecs and in dysarthrics it is 4 Hz /millisecs.

Mean of speed of transition is 4Hz /millisecs is respective of the group type below 60 years and for dysarthrics above 60 years mean of speed of transition is 4 Hz / millisecs and it is 5 Hz / millisecs for normals above 60 years.

For the consonant /g/ mean of speed of transition for normal is 5 Hz /millisecs and it is 9Hz /millisecs for dysarthrics. In normals mean of speed of transition for

/kl is 4 Hz /millisecs and for dysarthrics it is 5 Hz /millisecs.

For short vowels in normals, mean of speed of transition is 5 Hz / millisecs and in dysarthrics mean of speed of transition for short vowels is 6 Hz /millisecs and for long vowels irrespective of the group type it is 4Hz / millisecs.

In terms of position in normals mean of speed of transition for consonants in initial position is 5Hz /millisecs and it is 4 Hz /millisecs for final position consonants. In dysarthrics, mean of speed of transition for initial, medial and final positions is 5 Hz /millisecs, 4 Hz / millisecs and 2 Hz / millisecs respectively.

TABLE 8(b): Level of significance for various factors

FACTORS	SIGNIFICANCE
GROUP	.427
AGE	.475
CONSONANT	.247
VOWEL	.001
POSITION	.002

For various factors, level of significance has been determined using 5 way ANOVA.

The results are as follows:

(i) There is a significant difference in the mean of speed of transition for short and long vowels following the consonants /k/ and /g/ in both normals and dysarthrics.

(ii) As position of occurrence of /k/ and /g/ in initial, medial and final position of a word is a factor, post hoc test has been used to find the influence of position type. It is found that initial medial, initial final position of /k/ and /g/ there is a significant difference between the normal geriatric group and dysarthric group.

Acoustic analysis of the speech of dysarthrics and normal geriatrics indicates that all the durational parameters are increased in dysarthrics while compared to normals. In severe dysarthrics these durational parameters are found to be increased further than in mild and moderate dysarthrics.

Qualitative observations carried out during the acoustic analysis also indicates the following in dysarthric group-

Continuation of formant transitions from one segment to another without gaps between segments resulting in the absence of burst and stop closure.

Presence of multiple peaks.

Often, it is seen that severe dysarthrics produced four syllabic words with a break in the word between two bi-syllabic utterances. Closure duration has been considered to be absent when the words are broken up.

Presence of noise during burst and also during stop closure.

The qualitative observation in normal geriatrics above 60 years is the presence of continuous formant transition from one segment to another segment resulting in the absence of burst and stop closure.

In general, it has been observed that there are overlapping acoustic features both in normal geriatrics and dysarthrics but the frequency of occurrence of these acoustic features is more in dysarthrics when compared to normal geriatrics.

PERCEPTUAL ANALYSIS:

For perceptual analysis, the recorded speech samples of the dysarthrics and normal geriatrics were randomized and played to a judge who was a qualified Speech and Language Pathologist with clinical experience in dysarthria for more than five years.

The judge was given a response sheet with the speech dimensions and rating scale to be used. (See Appendix-III). The judge was asked to rate the speech on 31 speech dimensions (appropriate speech dimensions are adopted from study by Darley et al. (1969) and Ingram et al. (1988) using a 5 point rating scale. The judge was instructed to concentrate only on /k/ or /g/ phonemes occurring in different positions in the words. To make the task easier for the perceptual judgement each word was repeated twice.

The 31 speech dimensions (see Appendix II) were classified under the following speech parameters:

i. Respiratory Parameters
ii. Laryngeal Parameters
iii. Resonatory Parameters
iv. Articulatory Parameters
v. Prosodic Parameters and
vi. Overall Intelligibility

1. RESPIRATORY PARAMETERS:

The two respiratory parameters which were considered for perceptual judgement of respiration in normals and dysarthrics are:

- Audible Inspiration
- Forced Respiration

The perceptual judgement of the respiratory parameters in terms of the percentage identification are represented in Graph (1) while Graph (2) shows the severity rating both in normals and dysarthrics for the respiratory parameters:

The graphs (1) and (2) indicates the following:

Both the respiratory parameters are identified as being present but the percentage identification of these parameters are different in normals and dysarthrics.

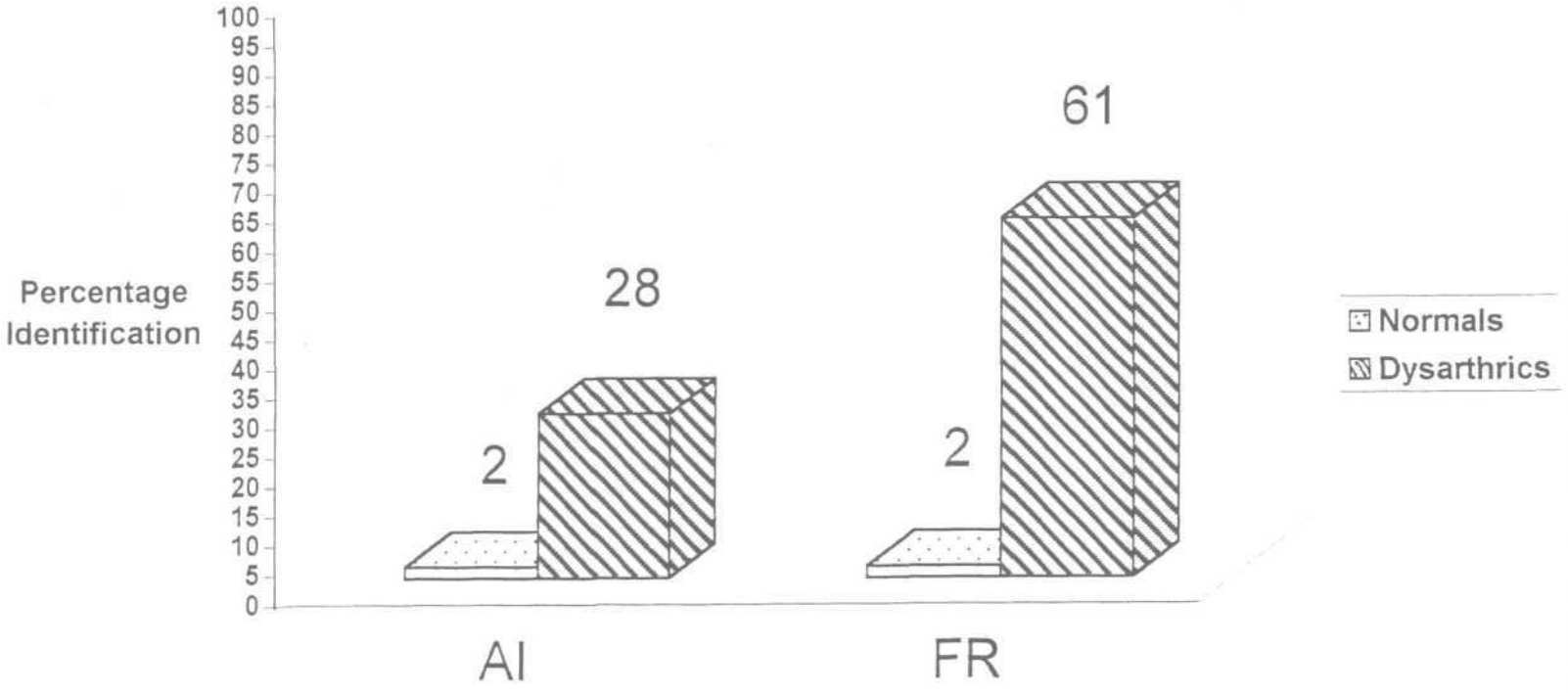
Audible Inspiration has been identified 2% of the time in normals and 28% of the time in dysarthrics.

In normals, Forced Respiration is identified 2% of the time and in dysarthrics Forced Respiration is identified 61% of the time.

As indicated earlier, these parameters are rated on a 5 point scale.

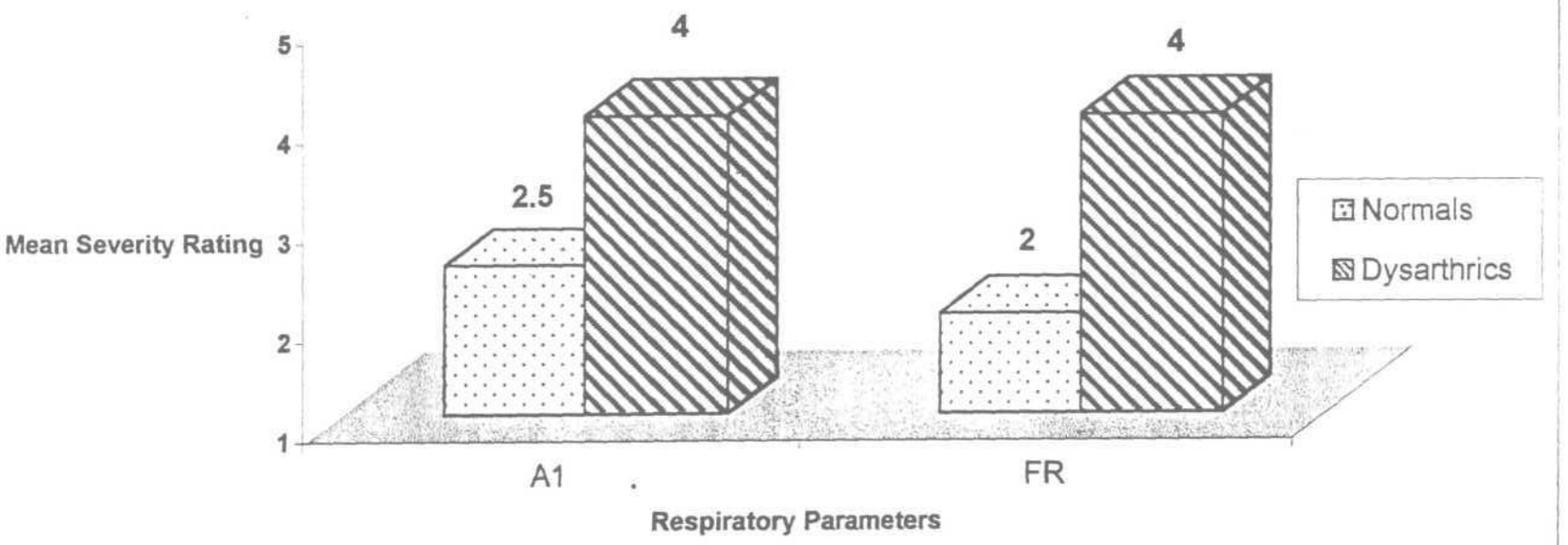
Observation of graph (2) indicates the following:

GRAPH (1) : PERCENTAGE IDENTIFICATION OF RESPIRATORY PARAMTERS IN NORMAL GERIATRICS AND DYSARTHRICS



AI : AUDIBLE INSPIRATION
FR : FORCED RESPIRATION

GRAPH (2): MEAN SEVERITY OF RESPIRATORY PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



1 : No Abnormality
2 : Mild Abnormality
3 : Moderate Abnormality
4 : Severe Abnormality
5 : Profound Abnormality

AI : Audible Inspiration
FR : Forced Respiration

The mean severity rating in normals for Audible Inspiration is 2.5 and in dysarthrics rating is 4.

For Forced Respiration mean severity rating for normals is 2 and for dysarthrics it is 4.

The data was analyzed to look into the influence of age in the normal geriatric and dysarthric group below and above 60 years.

The percentage identification of Audible Inspiration in normals below 60 years is 5% and in dysarthrics below 60 years is 64%

Percentage identification of Forced Respiration in normals above 60 years is 2 and in dysarthrics above 60 years is 57%.

The mean severity rating in normals below 60 years for Audible Inspiration is 2 and for Forced Respiration in normals below 60 years mean severity rating is 2.

The mean severity rating in normals above 60 years for Audible Inspiration is 3.5 and for Forced Respiration mean severity rating is 4.

For normals above 60 years mean severity rating for Audible Inspiration is 3 and for Forced Respiration mean severity rating is 2.6.

For dysarthrics above 60 years mean severity rating for Audible Inspiration is 4. For Forced Respiration in dysarthrics above 60 years mean severity rating is 4.

It is also noted that in dysarthrics the number of times (in percentage) the respiratory parameters are identified is increased. The severity rating of these parameters is also found to be increased. This can be attributed to the influence of disease condition on physiological aging.

Both Audible Inspiration and Forced Respiration are overlapping features in normal geriatrics and dysarthrics.

(ii) LARYNGEAL PARAMETERS

The different laryngeal parameters which were adopted for perceptual judgement are:

Pitch Level (low)

Pitch Level (high)

Pitch Breaks

Loudness Variation

Loudness Decay

Hoarse Voice

Strained-strangled Voice

Harsh Voice

Voice Tremors

Voice Stoppage

All the laryngeal parameters mentioned above are perceptually identified as being present either in normals/dysarthrics or in both. But the percentage identification and severity rating is different for normals and dysarthrics.

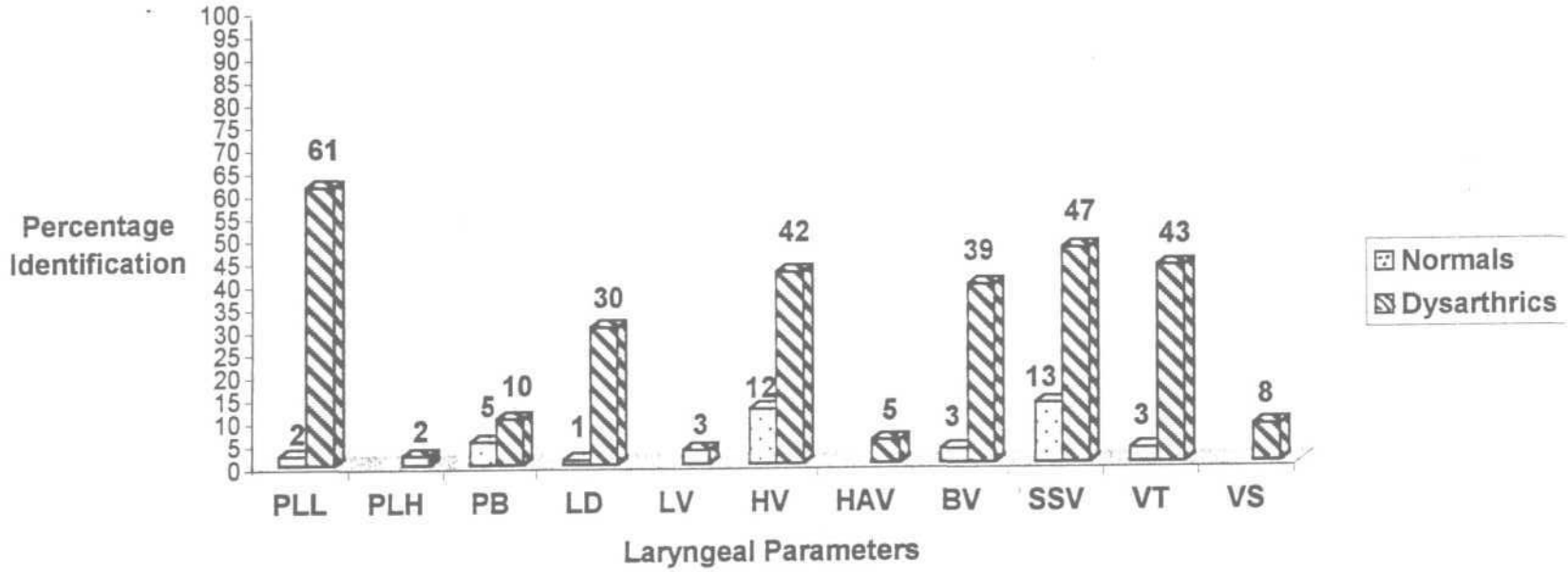
Observation of Graph (3) and (4) shows that

Pitch Level (low) has been identified 2% of the time in normals and 61% of the time in dysarthrics. The mean severity rating for the same parameter in normals is 2 whereas in dysarthrics the mean severity rating is 5.

Pitch Level (High) has not been observed in normals whereas in dysarthrics it is identified 2% of the time and its mean severity rating is 4.

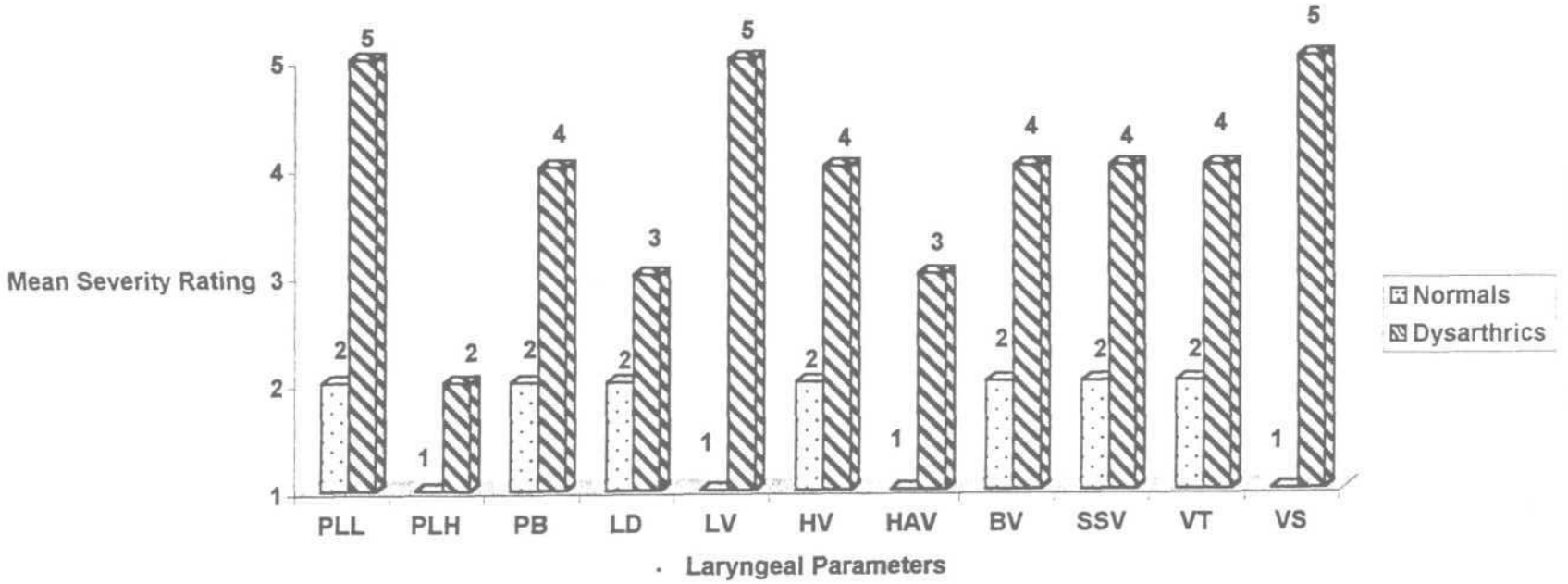
Pitch Breaks are found in both normals and dysarthrics. Pitch Breaks have been identified 5% of the time in normals and its mean severity rating is 2. In dysarthrics,

GRAPH (3): PERCENTAGE IDENTIFICATION OF LARYNGEAL PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



PLL : PITCH LEVEL (LOW)
PLH : PITCH LEVEL (HIGH)
PB : PITCH BREAKS
LD : LOUDNESS DECAY
LV : LOUDNESS VARIATION
HV : HOARSE VOICE
HAV : HARSH VOICE
BV : BREATHY VOICE
SSV : STRAINED - STRANGLED VOICE
VT : VOICE TREMORS
VS : VOICE STOPPAGE

GRAPH (4): MEAN SEVERITY RATING OF LARYNGEAL PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



1 : No Abnormality
2 : Mild Abnormality
3 : Moderate Abnormality
4 : Severe Abnormality
5 : Profound Abnormality

PLL : PITCH LEVEL (LOW)
PLH : PITCH LEVEL (HIGH)
PB : PITCH BREAKS
LD : LOUDNESS DECAY
LV : LOUDNESS VARIATION
HV : HOARSE VOICE
HAV : HARSH VOICE
BV : BREATHY VOICE
SSV : STRAINED - STRANGLED VOICE
VT : VOICE TREMORS
VS : VOICE STOPPAGE

10% of the time pitch breaks are identified and the mean severity rating is 4.

Loudness Variation has been identified only in dysarthric group and is observed 3% of the time and its mean severity rating is 5.

Loudness Decay is yet another laryngeal parameter which is identified both in normals and in dysarthric group. It is identified 1% of the time in normals and in dysarthrics it is observed 30% of the time. The mean severity rating of Loudness Decay in normals is 2 and in dysarthrics it is 3.

Hoarse Voice is identified 12% of the time in normals and its mean severity rating is 2 whereas in Dysarthrics, Hoarse Voice has been identified 42% of the time and its mean severity rating is 4.

In normals, Breathy Voice is identified 3% of the time and its mean severity rating is 2. In dysarthrics Breathy Voice is identified 39% of the time and its mean severity rating is 4.

Strained Strangled Voice has been identified 13% of the time in normals and 47% of the time in dysarthrics. The mean severity rating in normals is 2 and in dysarthrics it is 4.

Voice Tremors is identified 2% of the time in normals whereas it is observed 43% of the time in dysarthrics. The mean severity rating of Voice Tremors in normals is 2 whereas in dysarthric it is 4.

Voice Stoppage is identified only in dysarthrics 8% of the time and its mean severity rating is 5.

When the perceptual judgement has been observed for the influence of aging (i.e.,) in normals and dysarthrics below and above 60 years, the following are noticed.

Pitch Level (low) in normals below 60 years have been identified 27% of the time and its mean severity rating is 3. For normals above 60 years, 40% of the time Pitch Level (low) is identified with a mean severity rating of 2. In dysarthrics below 60 years 27% of the time it has been identified and its mean severity rating is 3 while in

dysarthrics above 60 years, the percentage identification is 41% and its mean severity rating is 2.

Pitch Breaks are identified in normals above 60 years of age, 5% of the time with a mean severity rating of 2. In dysarthrics below 60 years, Pitch Breaks are identified 7% of the time and its severity rating is 3.5 and in dysarthrics above 60 years 13% of the time Pitch Breaks have been identified and its mean severity rating is 4.

Loudness Variation is identified in normals above 60 years of age with 1% as its percentage identification and with mean severity rating of 3. In dysarthrics below 60 years Loudness Variation is identified 2% of the time and its mean severity rating is 2. For dysarthrics above 60 years percentage identification of Loudness Variation is 3% with a mean severity rating of 5.

Loudness Decay in normals below 60 years of age is identified 0.5% of the time and its mean severity rating is 2. In normals above 60 years Loudness Decay is identified 1% of the time and its severity rating is 3. In dysarthrics below 60years of age 25% of the time

Loudness Decay has been identified with a mean severity rating of 5. In dysarthrics above 60 years it is identified 35% of the time and its severity rating is 5.

Hoarse Voice in normals below 60 years is identified 2% of the time and in normals above 60 years also it is identified 2% of the time. The mean severity rating in normals below and above 60 years of age Hoarse Voice is identified 38% of the time and its mean severity rating is 4 whereas in dysarthrics above 60 years percentage identification is 47% with mean severity rating of 4.

Harsh Voice has been identified only in dysarthrics. In dysarthrics below 60 years percentage identification is 8% and its mean severity ratings 4. In dysarthrics above 60 years of age Harsh Voice has been identified 2% of the time with 5 as its mean severity rating.

Strained-Strangled Voice is identified 20% of the time in normals below 60 years of age and its mean severity rating is 2. In dysarthrics below 60 years, it is identified 41% of the time and its mean severity rating is 4. In normals above 60 years Strained Strangled Voice has

been identified 6.5% of the time and its mean severity rating is 2 whereas in dysarthrics above 60 years it is identified 54% of the time with mean severity rating of 4.

Voice Stoppage has been identified only in dysarthrics. In dysarthrics below 60 years it has been identified 8% of the time and its mean severity rating is 5. In dysarthrics above 60 years, Voice Stoppage has been identified 9% of the time and its mean severity rating is 5.

Voice Tremors in normals above 60 years have been identified 3% of the time and its mean severity rating is 2. In dysarthrics below 60 years it is identified 78% of the time and its mean seventy rating is 5 whereas in dysarthrics above 60 years it is identified 10% of the time and its mean severity rating is 4.

From the results of this study it is noted that the percentage identification of the laryngeal parameters are increased in dysarthrics and also higher severity rating is indicated.

This indicates that these parameters are affected more frequently and more severely in dysarthrics. Graph (3) shows that Strained Strangled Voice is identified the most. (50% of the time). This is in agreement with the study by Darley et al. (1969) wherein Strained - Strangled Voice is identified as the prominent feature in spastic type of dysarthrics . This has also been identified in normal geriatrics (15% of the time). This can be due to increased Laryngeal tension in geriatrics . According to Ryan and Burk (1974) laryngeal tension is one of the prominent feature seen in geriatrics.

Low pitch has been identified 35% of the time in dysarthrics. This is in agreement with the study by Darley et al. (1969) .

Only 2% of the time, high pitch is identified. In normal geriatrics, pitch level has never been judged as high. This is similar to the results of several studies (Mc.Glone and Hollien(1963), Hollien and Shipp(1972), Weismer and Hartman(1979), which report that pitch level in males decreases with advancing age. This result is in contrast to the study by Honjo and Isshiki(1980) where they found pitch level to increase in geriatric males because of vocal fold atrophy.

Hoarse Voice is identified in normals 10% of the time and it is judged to be mildly affected with severity rating of 2 whereas in dysarthrics, it is identified 40% of the time with a mean severity rating of 4.

According to Ryan and Burk (1976) Hoarse voice is one among the five prominent features for the identification of geriatrics. Hoarseness has been identified in normal geriatrics in this study agreeing with the study by Ryan and Burk(1976). But the identification of Hoarse Voice in dysarthrics is in contrast to the study by Darley et al. (1969) where hoarse voice is not found to be prominent in spastic dysarthrics.

Breathy voice has been identified both in normal geriatrics and dysarthrics. Presence of breathiness in speech of dysarthrics is in agreement with Darley et al. (1969) study where spastic dysarthrics are found to have continues Breathy Voice.

Hoarse and Breathy Voice quality in normal geriatrics can be explained by:

a. Bowing of the vocal folds which is more prominent in normal geriatrics (Segre (1971), Honzo and Issihiki(1980).

b. Larger percentage of vital capacity per syllable (Hoit and Hixon, 1987).

Pitch Breaks, Loudness Variation and Loudness Decay have been identified in dysarthrics. Study by Darley et al. (1069) has not considered these laryngeal parameters as most prominent features in spastic dysarthrics. But according to the present study these parameters have been identified less frequently and with low mean severity rating. These parameters have also been identified in normal geriatrics.

Voice Tremors has been identified in normal geriatrics and dysarthrics. According to Ryan and Burk (1976) voice tremors is a prominent feature in aged population which is in agreement with the result of the present study.

Voice Stoppage is present/identified in dysarthrics. This is in contrast to Darley et als' (1969) study where voice tremors and voice stoppage have not been considered as prominent features

perceptually in spastic dysarthrics. The salient laryngeal features obtained in dysarthrics are-

High Pitch

Harsh Voice

Loudness Variation

Voice Stoppage

Overall it has been observed that there are several overlapping laryngeal parameters between the normal geriatric group and dysarthric group. Overlap in the parameters indicates that normal aging has an effect on these parameters. Among the overlapping parameters, these parameters are identified more frequently in dysarthrics and the severity by which it is rated indicates that they are affected more severely. This increase in severity is due to the disease condition upon the normal aging process. The exclusive laryngeal features in dysarthrics are High Pitch, Harsh Voice, Voice Stoppage and Loudness Variation.

(iii) RESONATORY PARAMETERS:

Three resonatory parameters have been considered across which the perceptual judgement is to be carried out. The three resonatory parameters are:

Hyper-nasality

Hypo-nasality

Nasal Emission

Graphs (5) and (6) indicates that

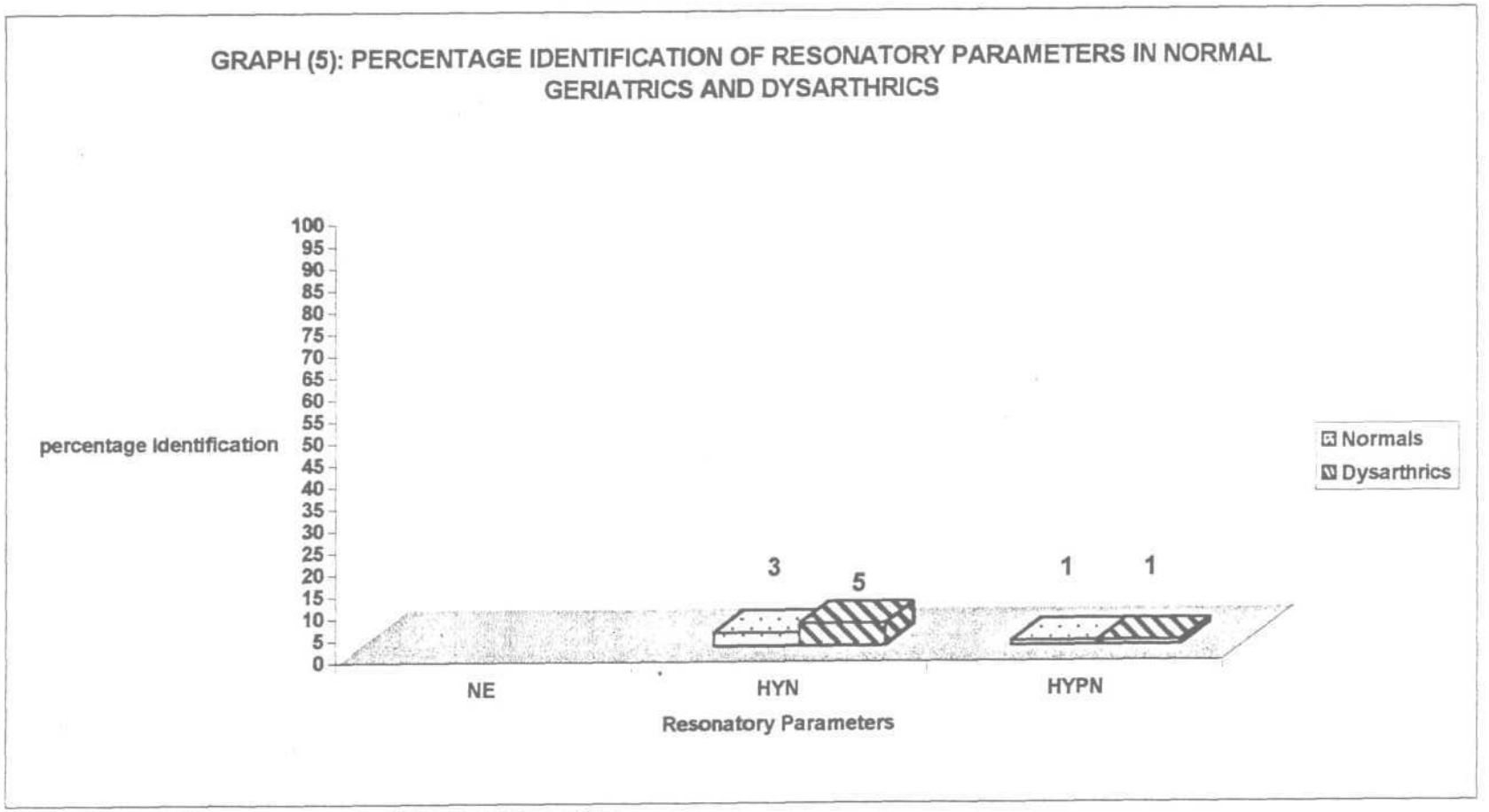
Nasal Emission has never been identified either in normals or in dysarthrics.

Hyper-Nasality has been identified 3% of the time in normals and 5% of the time in dysarthrics. The mean severity rating of Hyper-Nasality is 2 in normals and 3 in dysarthrics.

Hypo-Nasality has been identified both in normals and in dysarthrics. The percentage identification of Hypo-Nasality in normals is 1% and its mean severity rating is 2. In dysarthrics Hypo-Nasality is identified 1% of the time with mean severity rating of 3.

When these resonatory parameters were compared based on the age below and above 60 years in normals and dysarthrics the following are noted.

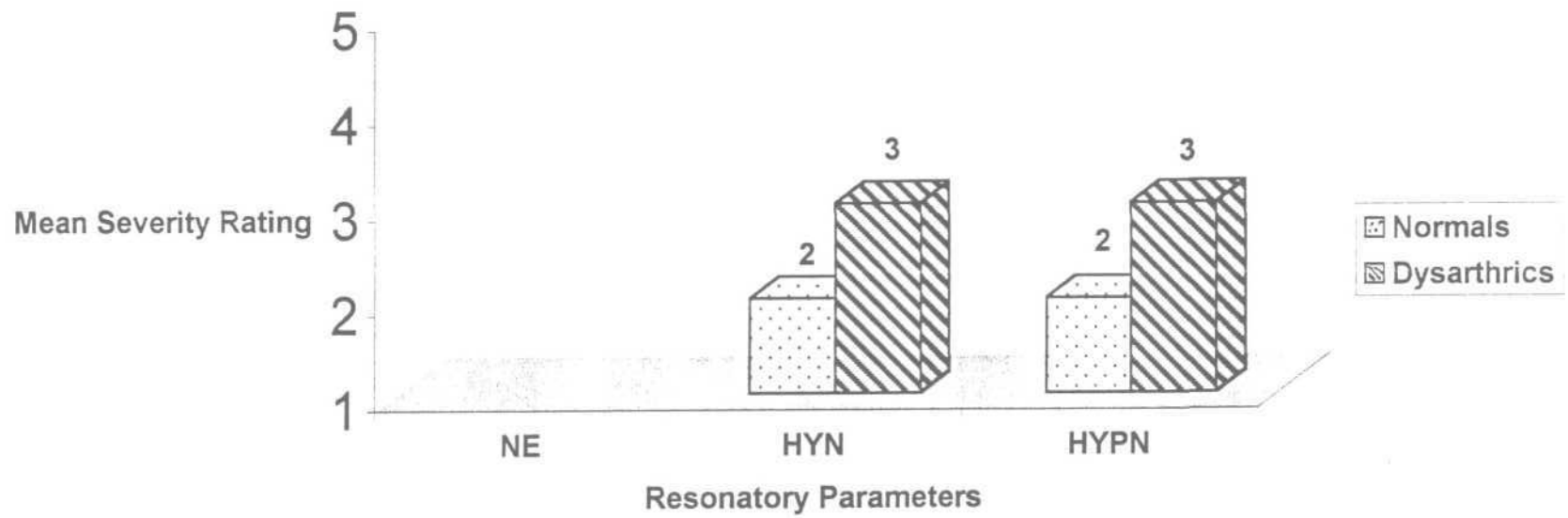
GRAPH (5): PERCENTAGE IDENTIFICATION OF RESONATORY PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



1 : No Abnormality
2 : Mild Abnormality
3 : Moderate Abnormality
4 : Severe Abnormality
5 : Profound Abnormality

NE : NASAL EMISSION
HYN : HYPER NASALITY
HYPN : HYPO NASALITY

GRAPH (6) : MEAN SEVERITY RATING OF RESONATORY PARAMETERS



1 : No Abnormality
2 : Mild Abnormality
3 : Moderate Abnormality
4 : Severe Abnormality
5 : Profound Abnormality

NE : NASAL EMISSION
HYN : HYPER NASALITY
HYPN : HYPO NASALITY

In normals below 60 years Hyper-Nasality has been identified 3% of the time and its mean severity rating is 2. In dysarthrics below 60 years, 8% of the time it is identified and its mean severity rating is 2 whereas in dysarthrics above 60 years it is identified 2% of the time with mean severity rating of 5.

Hyper-Nasality has been identified more number of times both in normal geriatrics and dysarthrics. Hyper-Nasality can be due to slow and sluggish velopharyngeal movement (Duffy,1995). Hyper-nasality has been observed by Darley etals" (1969) perceptual study which is in agreement to the present study.

Hyper-Nasality and Hypo-Nasality are the overlapping resonatory parameters between normal geriatrics and dysarthrics.

(iv) ARTICULATORY PARAMETERS:

The following are the articulatory parameters considered for perceptual judgement

Distorted Vowels

Phoneme Prolongation

Phoneme Repetition

Phoneme Substitution

Phoneme Distortion

Phoneme Deletion

Phoneme Addition

Observation of Graph (7) and (8) indicates the following:

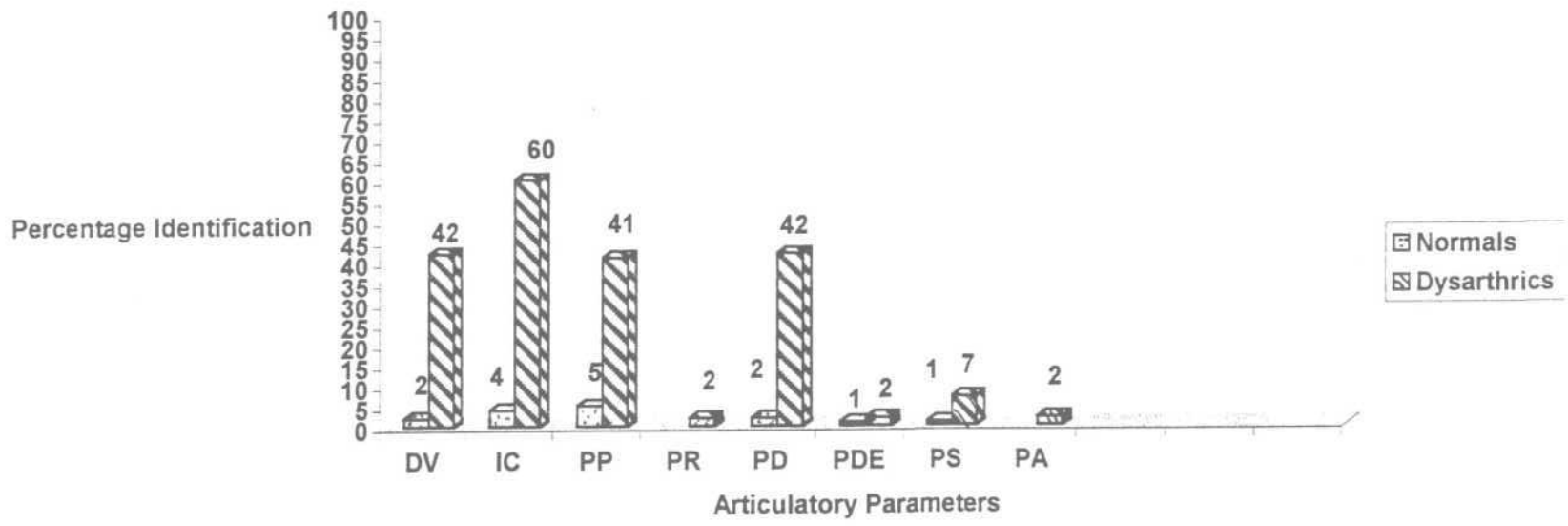
Distorted Vowel has been identified in normal geriatrics 2% of the time and mean severity rating is 2. In dysarthrics Distorted Vowels has been identified 42% of the time and the mean severity rating for Distorted Vowels in dysarthrics is 4.

Imprecise Consonant is identified 4% of the time in normals and 60% of the time in dysarthrics. The mean severity rating of Imprecise Consonant in normals is 3 and in dysarthrics it is 3.

In normals, Phoneme Prolongation is identified 5% of the time and in normals it is identified 41% of the time .The mean severity rating for normals for Phoneme Prolongation is 3 and for dysarthrics it is 4.

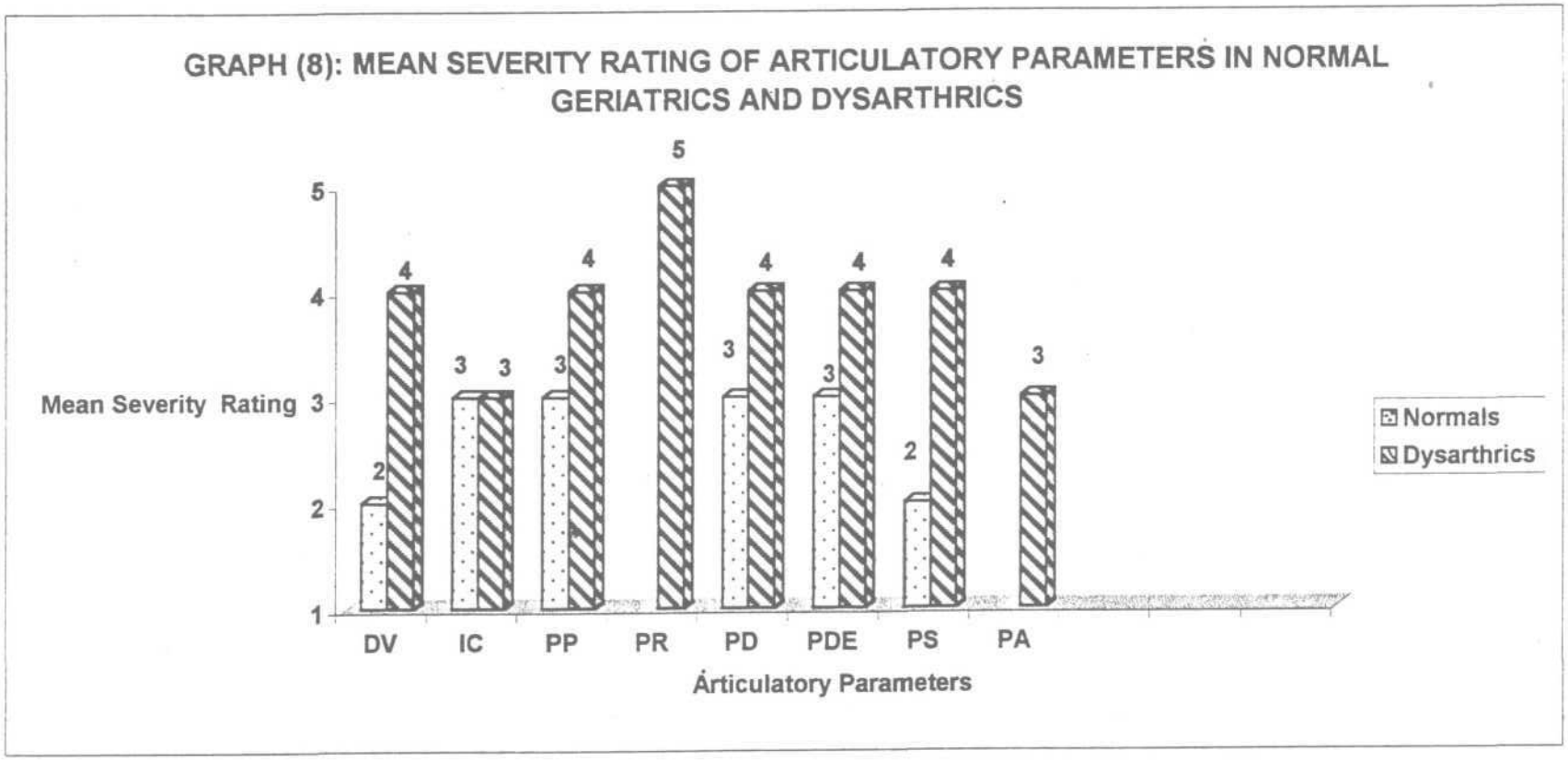
Phoneme Repetition has been identified only in dysarthric group and it is identified 2% of the time and its mean severity rating is 5.

GRAPH (7): PERCENTAGE IDENTIFICATION OF ARTICULATORY PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



DV : DISTORTED VOWELS
IC : IMPRECISE CONSONANTS
PP : PHONEME PROLONGATION
PR : PHONEME REPETITION
PD : PHONEME DISTORTION
PDE : PHONEME DELETION
PS : PHONEME SUBSTITUTION
PA : PHONEME ADDITION

GRAPH (8): MEAN SEVERITY RATING OF ARTICULATORY PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



1 : No Abnormality
2 : Mild Abnormality
3 : Moderate Abnormality
4 : Severe Abnormality
5 : Profound Abnormality

DV : DISTORTED VOWELS
IC : IMPRECISE CONSONANTS
PP : PHONEME PROLONGATION
PR : PHONEME REPETITION
PD : PHONEME DISTORTION
PDE : PHONEME DELETION
PS : PHONEME SUBSTITUTION
PA : PHONEME ADDITION

Phoneme Addition is also identified only in dysarthrics. Its mean severity rating is 3 and it has been identified 2% of the times.

In normals, Phoneme Distortion has been identified 2% of the time and its mean severity rating is 3 whereas in dysarthrics, Phoneme Distortion has been identified 42% of the time and the mean severity rating for Phoneme Distortion is 4.

Phoneme Deletion is identified in normals 1% of the time and in dysarthrics it is identified 2% of the time. The mean severity rating for Phoneme Deletion in normals is 3 and in dysarthrics it is 4.

Phoneme Substitution has been identified 1% of the time in normals and its mean severity rating is 2 whereas in dysarthrics it is identified 7% of the time and its mean severity rating is 4.

Observation of data in age groups below and above 60 years indicates.

Distorted Vowels are identified in normals below 60 years 3% of the time and in dysarthrics below 60yrs it is identified 37% of the time. The same parameter is identified 1% of the time in normals above 60 years and 47% of the time in dysarthrics above 60 years of age. The mean severity rating for Distorted Vowels in normals below 60 is 2 and in normals above 60 it is 3. Mean severity rating is dysarthrics below 60 years is 3 and for dysarthrics above 60yrs the mean severity rating is 4.

6% of the time imprecise consonants has been identified in normals below 60yrs and 4% in normals above 60yrs. The mean severity rating for imprecise consonants is 2 in normals below 60 years and it is 3 in normals above 60yrs whereas in dysarthrics below 60 years of age, imprecise consonants is identified 57% of the times and its mean severity rating is 3. In dysarthrics above 60 years percentage identification of imprecise consonant is 64% and its mean severity rating is 4.

Phoneme Prolongation has been identified 1% of the time by normals below 60yrs of age and its mean severity rating is 2. In normals above 60yrs percent

identification of phoneme prolongation is 9% and its means severity rating is 3. In dysarthrics above 60 years this is identified 39% of the times and its mean severity rating is 4.

Phoneme Repetition and phoneme Addition have not been identified in normals whereas in dysarthrics below 60 years, phoneme repetition is not identified and in dysarthrics above 60 years it is identified 2% of the time and its mean severity rating is 5. Phoneme Addition has been identified 2% of the time and its mean severity rating is 3 for dysarthrics below 60 years of age and the percent identification for dysarthrics above 60 years is 0%.

3% of the time phoneme distortion is found to be identified in normals below 60 and its mean severity rating is 3 whereas in normals above 60 years, phoneme distortion identification is 7% of the times and the mean severity rating is 3. In dysarthrics below 60, percent identification of phoneme distortion is 39% of which its mean severity rating is 4. In dysarthrics above 60, 5%

of the time phoneme Distortion has bee identified and the mean severity rating is 5.

Phoneme Deletion is found to be identified in normals below 60 years 0.5% of the times and 1.3 of the times in normals above 60 years. The mean severity rating in normals below 60 is 2 and in normals above 60 years is 3. In dysarthrics below 60 years, phoneme Deletion is identified 3% of the times and its mean severity rating is 4 whereas in dysarthrics above 60 years. Phoneme Distortion has been identified 0.6% of the times and its mean severity rating is 5.

2% of the times phoneme substitution is identified in normals below 60 years of age and 0.6% of the times above 60yrs of age . The mean severity rating in normals below 60 is 3 and in normals above 60 is 2. Phoneme substitution is 4% of the times in dysarthrics below 60 and its mean severity rating is 4 whereas in dysarthrics above 60, 10% of the times it has been identified and its mean severity rating is 4.

Overall it is found that the articulatory parameters are identified few number of times in normals and hence the percentage identification in normals is much less than the percentage identification in dysarthrics for the overlapping articulatory parameters. Apart from the overlapping articulatory parameters, there are few salient, articulatory parameters in dysarthrics. They are:

Phoneme Repetition

Phoneme Addition

Phoneme distortion and phoneme deletion can be considered to be contributing factors for imprecise consonant production both in normal geriatrics and dysarthrics. Imprecise consonant production has been observed both in geriatric and dysarthrics in several studies. According to the perceptual study by Darley et al. (1969) imprecise consonant production is the most prominent feature in spastic dysarthric Ryan and Burk (1974) considered imprecise consonant production as one of the important feature for the identification of aging.

The overlapping articulatory parameters between the normal geriatric group and dysarthric group are phoneme prolongation, phoneme substitution, phoneme distortion, phoneme deletion, distorted vowels, imprecise consonants and the salient articulatory

parameters in dysarthrics are phoneme addition and phoneme repetition.

5. PROSODIC PARAMETERS:

The following are the prosodic parameters taken up based on which the speech samples of normal geriatrics and dysarthrics were perceptually judged

Inflection (monotone)

Stress Pattern (Excessive)

Stress Pattern (Reduced)

Rate (Slow)

Rate (Rapid)

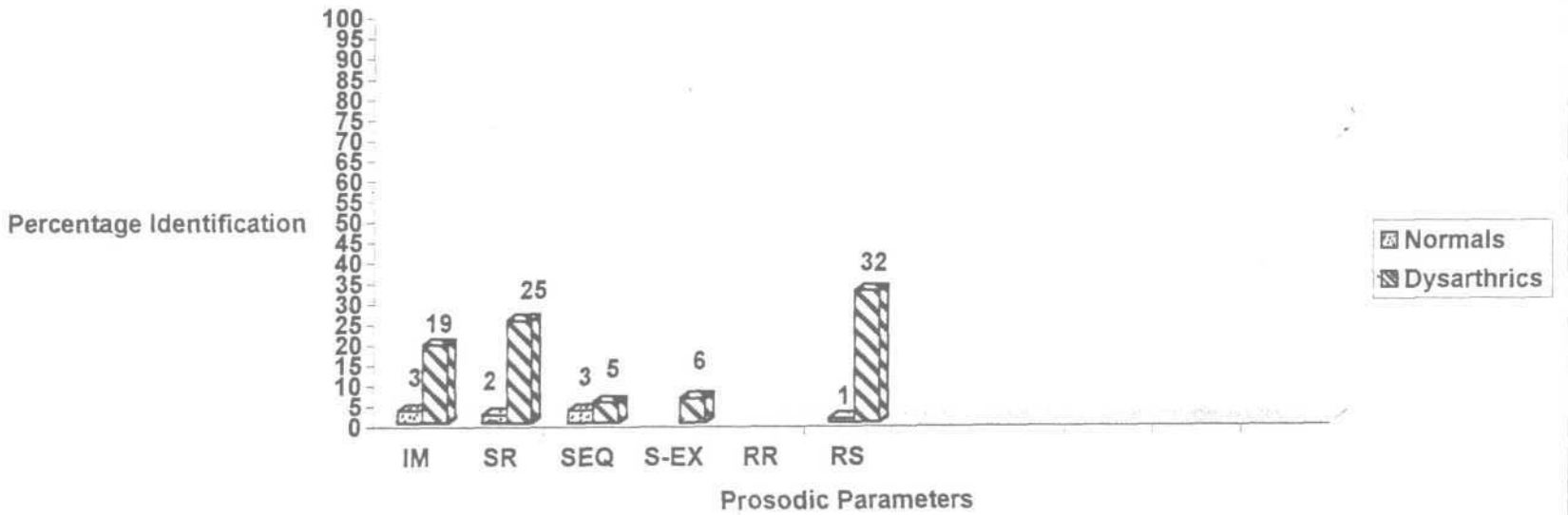
Among the above mentioned parameters, rapid rate was never been identified in normals as well as in dysarthrics.

Observation of the graphs (9) and (10) indicates the following:

Inflection (monotone) is identified in normals 3% of the time and in dysarthrics it is identified 19% of the time. The mean severity rating in normals is 2 whereas in dysarthrics it is 4.

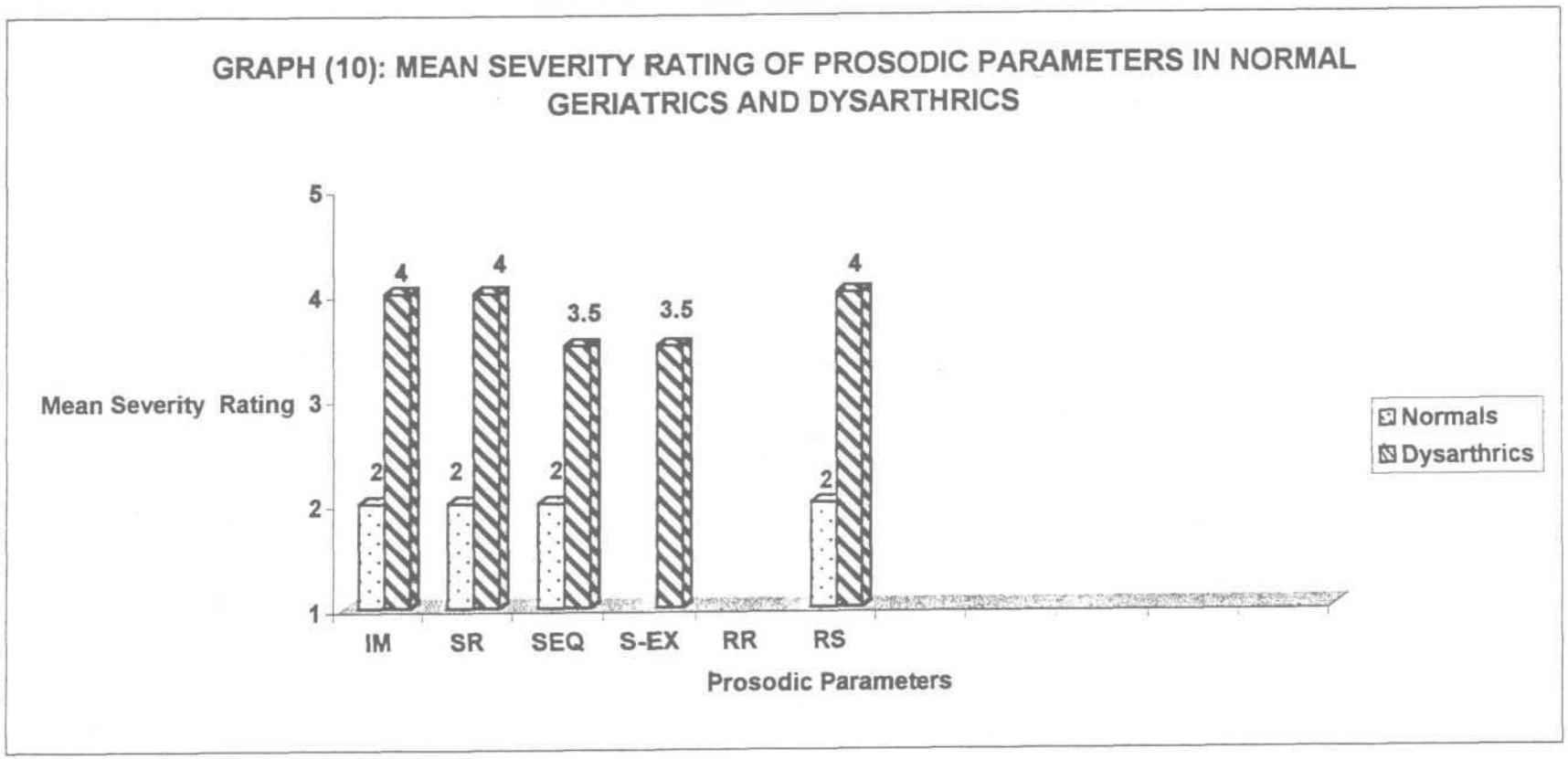
In normals, stress (excessive) has never been identified whereas in dysarthrics it has been identified 6% of the time and its mean severity rating is 3.5

GRAPH (8): PERCENTAGE IDENTIFICATION OF PROSODIC PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



IM : INTONATION (MONOTONE)
S-R : STRESS (REDUCED)
S-EX : STRESS (EXCESS)
S-EQ : STRESS (EQUAL)
R-S : RATE (SLOW)
RR : RATE (RAPID)

GRAPH (10): MEAN SEVERITY RATING OF PROSODIC PARAMETERS IN NORMAL GERIATRICS AND DYSARTHRICS



1 : No Abnormality
2 : Mild Abnormality
3 : Moderate Abnormality
4 : Severe Abnormality
5 : Profound Abnormality

IM : INTONATION (MONOTONE)
S-R : STRESS (REDUCED)
S-EX : STRESS (EXCESS)
S-EQ : STRESS (EQUAL)
R-S : RATE (SLOW)
RR : RATE (RAPID)

Reduced stress is identified 2% of the time in normals and in dysarthrics it is identified 25% of the time. The mean severity rating in normals is 2 for normals and in dysarthrics mean severity rating is 4.

Stress (equal) has been identified 3% of the time in normals and in dysarthrics it has been identified 5% of the time. The mean severity rating in normals for equal stress is 2 whereas in normals it is 3.5.

In normals, slow rate is identified 1% of the time and its mean severity rating is 2. In dysarthrics slow rate is identified 32% of the time and its mean severity rating is 4.

When data was analyzed for the age group i.e. above 60 years and below 60 years, the following are observed

Monotonous Pitch has not been identified in normals above 60 years of age whereas in normals below 60 years intonation has been identified as monotonous 3% of the time and its mean severity rating is 2.

In dysarthrics below 60 years of age, percent identification of intonation (monotone) is 14% and in dysarthrics above 60 years it is 25%. The mean severity rating of intonation (monotone) is 3 in dysarthrics below 60 years and 4 in dysarthrics above 60 years.

Reduced stress has never been identified in normals above 60 years whereas it has been identified 2% of the time in normals below 60 years and the mean severity rating is 2. In dysarthrics below 60 years, reduced stress is identified 18% of the times and its mean severity rating is 3. In dysarthrics above 60 years reduced stress is identified 33% of the times and its mean severity rating is 5.

Excessive stress pattern is absent in normals both above and below 60 years of age in dysarthrics below 60 years it is identified 4% of the time and its mean severity rating is 2 and it has been identified 9% of the times in dysarthrics above 60 years and its mean severity rating is 5.

Only in normals below 60 years of age, equal stress has been identified 3% of the times and tits mean severity rating is 2. In dysarthrics below 60 years of age 2% of the times equal stress has been identified and its mean severity rating is 2 and in dysarthrics above 60 years of age, equal stress is identified 10% of the times and its mean severity rating is 5.

2% of the times, slow rate has been identified in normals below 60 years of age and its mean severity rating is 2 whereas in normals above 60 years of age, slow rate is identified 0.3% of the times and its mean severity rating is 2. In dysarthrics below 60 years slow rate is identified 25% of the times and its mean severity rating is 4 and in dysarthrics above 60 years slow rate has been identified 39% of the times and its mean severity rating is 4.

There are several overlapping prosodic parameters between the normal geriatric and dysarthrics. This overlap indicates that aging has an effect on these parameters. The percentage identification of these prosodic parameters is increased in dysarthrics and also its severity rating in dysarthrics. This increase is due to the effect of aging and also due to disease condition.

Intonation is perceived to be monotonous in both dysarthric group and in normal geriatric group due to decrease in pitch variability. This is in agreement with the study in normal geriatrics by Mc Glone and Hollien (1963). But Mysak (1959) has reported of increased pitch variability with increase in age.

Among the several prosodic parameters slow rate is the most prominent perceptual feature and its identification is 32% of the times and its mean severity rating is 4 in dysarthrics. Perceptual study by Darley et al. (1969) agrees with this result. Slow rate has also been identified in normal geriatrics (1% of the time) Ryan and Burk (1974) have considered slow rate as one of the five prominent features in the identification of geriatrics. The result of this study is in agreement with the result of Ryan and Burk (1974).

It is found that in dysarthrics stress is equal and excessive. This is in agreement tot he perceptual study by Darley et al. (1969) where they identified spastic dysarthrics to have equal and excessive stress.

In general, there are several overlapping prosodic parameters between normal geriatrics and dysarthrics. The overlapping parameters are intonation (monotone) stress (reduced) stress

(equal) and slow rate. The salient prosodic feature of dysarthric is excessive stress. This increased stress also results in slow rate of speech production.

6. OVERALL INTELLIGIBILITY:

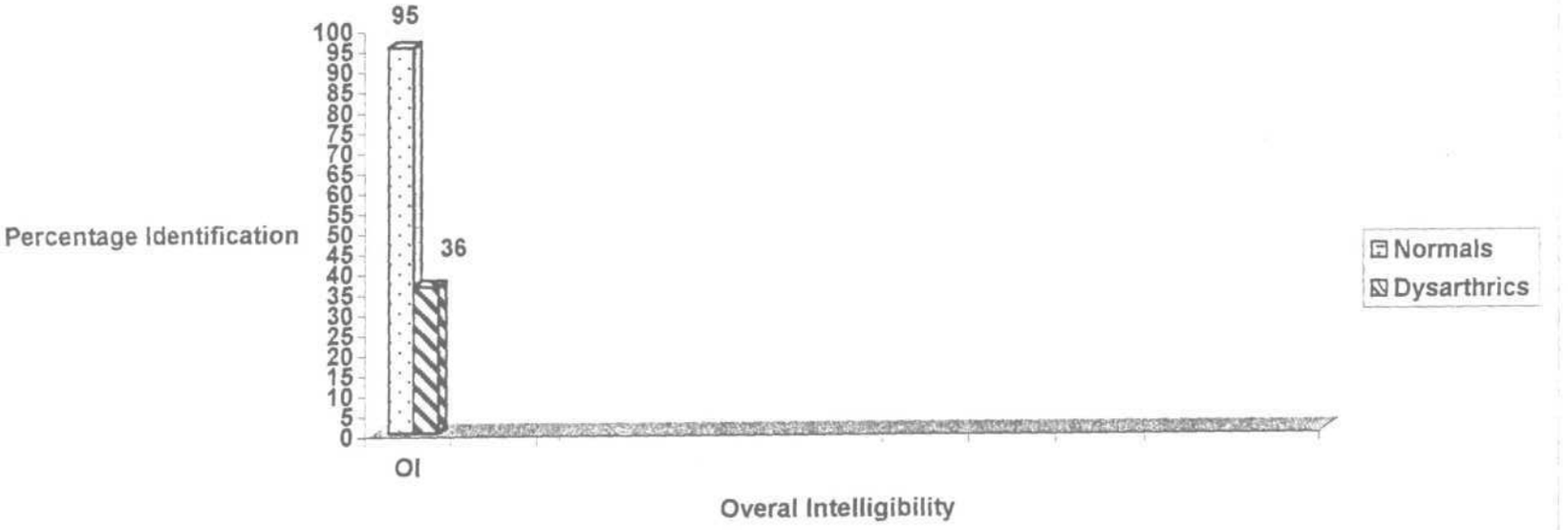
This refers to the clarity of speech. Criteria of judgement for overall intelligibility is different from the judgement criteria used for other parameters. Here the judge was asked to rate the overall intelligibility of the word rather than to perception judgement of the respiratory, phonatory, articulatory and resonatory parameters of the key phonemes /k/ and /g/. Percentage identification refers to the number of times overall intelligibility is identified as normal

In normals 95% of the times overall intelligibility has been identified as normal. In dysarthrics overall intelligibility is identified as normal 36% of the times.

When comparing normals and dysarthrics based on age with 60years as cut-off criteria, the following are observed.

In normals below 60 years 91% of the times overall intelligibility has been identified and in dysarthrics it is 37% of the time. The mean severity rating is normals below 60 years is 2 and in dysarthrics below 60 years mean severity rating is 4. Overall intelligibility is judged

GRAPH (11): PERCENTAGE IDENTIFICATION OF OVERALL INTELLIGIBILITY IN NORMAL GERIATRICS AND DYSARTHRICS



OI : OVERALL INTELLIGIBILITY

to be abnormals in normals above 60 years 5% of the time and its mean severity rating is 3. In dysarthrics above 60 years overall intelligibility has been identified as abnormal 66% of the time with a mean severity rating of 4.

It has been observed form perceptual analysis that there are several overlapping features in dysarthrics and normal geriatrics. The speech features which are overlapping in the dysarthrics group and normal geriatric group are:

- Audible Inspiration
- Forced Respiration
- Low Pitch
- Pitch Breaks
- Hoarse Voice
- Breathy Voice
- Strained Strangled Voice
- Voice Tremors
- Hypernasality
- Hyponasality
- Distorted Vowels
- Imprecise Consonants
- Phoneme Prolongation

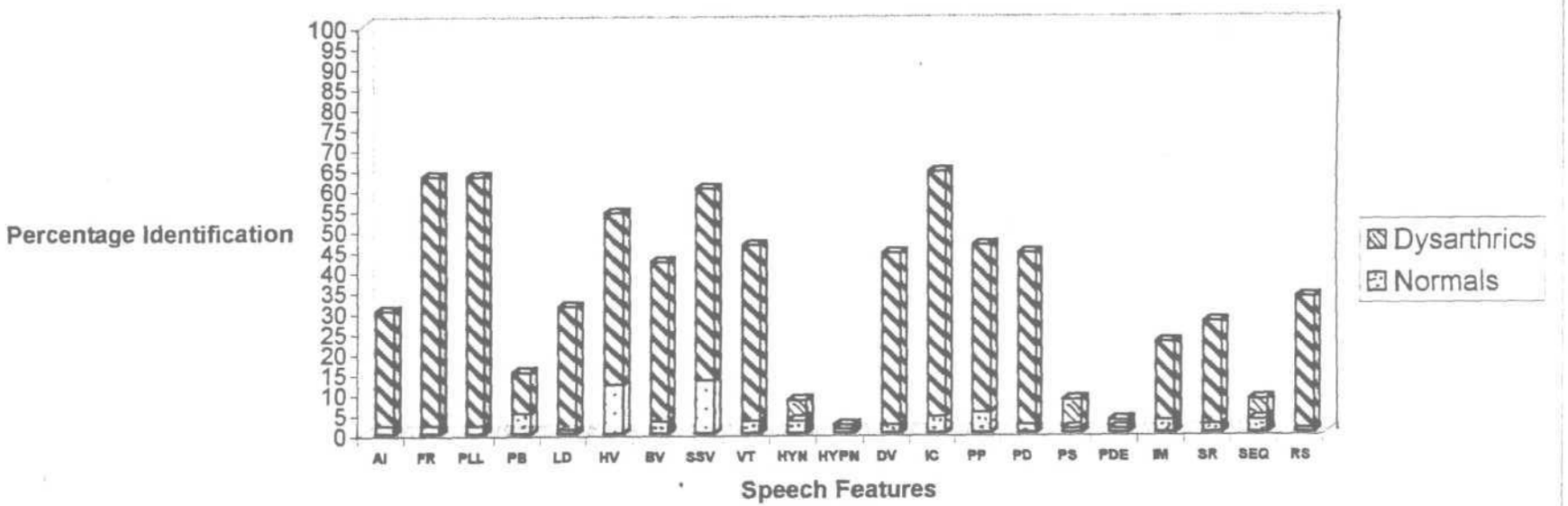
- Phoneme Distortion
- Phoneme Deletion
- Phoneme Substitution
- Intonation (monotone)
- Reduced Stress
- Equal Stress
- Slow Rate

From the graph it is observed that among the various speech parameters, the overlap between normal geriatric group and dysarthric group is higher for the laryngeal and articulatory parameters.

There are also a few salient speech features in observed in dysarthrics group. They are:

- High Pitch
- Loudness Variation
- Harsh Voice
- Voice Stoppage
- Phoneme Addition
- Excess Stress

GRAPH (12) : OVERLAPPING SPEECH FEATURES BETWEEN NORMAL GERIATRICS AND DYSARTHRICS



AI : AUDIBLE INSPIRATION
FR : FORCED RESPIRATION
PLL: PTICH LEVEL LOW
PB : PITCH BREAKS
LD : LOUDNESS DECAY
HV : HOARSE VOICE
BV : BREATHY VOICE
SSV: STRAINED –STRANGLED VOICE
VT: VOICE TREMORS
HYN : HYPERNASALITY

IC : IMPRECISE CONSONANT
DV : DISTORTED VOWELS
PP : PHONEME PROLONGATION
PD : PHONEME DISTORTION
PDE : PHONEME DELETION
PS : PHONEME SUBSTITUTION
IM : INTONATION (MONOTONE)
SR : STRESS (REDUCED)
SEQ : STRESS (EQUALS)
RS : RATE S LOW

The salient features of acoustic analysis in dysarthrics are as follows:

- Increase in following vowel duration, proceeding vowel duration, closure duration, burst duration, VOT, syllable duration and speed for transition
- Continues fornant transition from one speech segment to another segment with no gap between the segments resulting in absence of burst and stop closure.
- Presence of multiple bursts.
- Pressure of noise during stop closure and during burst.
- All the these acoustic features of dysarthrics can be collected with the following perceptual features.
- Slow rate and laborious quality of articulation.
- Judgement of equal stress due to slow rate of articulation.
- Imprecise consonant production.
- Breathy voice quality.

SUMMARY AND CONCLUSION

The process of aging is equally important as the developmental process. It has been found that aging is characterized by a progressive and insidious decline in functional process of most of the physiological systems. Among the various functional process . aging produces a predictable change in the acoustic parameters of speech. (Hutchinson and Beasley, 1976). There are characteristic changes reported in the manner and style of speaking that permits listeners to identify older people. Aged persons are more susceptible to neurological disease conditions which may affect their speech and/or language. In short, the aged person exhibits differences in oral communication either as a result of the normal aging process, neurological condition or both. Ryan and Burk (1974) expressed that the speech of the aged falls at the lower end of dysarthria continuum in severity. Hence if is of diagnostic significance to differentiate normal geriatric speech from the speech of dysarthrics.

This study was aimed to identify the speech features which were shared and/or exclusive to dysarthria and aging process.

The main objectives of this study are :

a. To perceptually and acoustically analyze the speech of normal geriatrics and dysarthrics.

b. To study the features which were exclusive in dysarthrics and normal geriatrics.

c. To study the features which overlapped in the dysarthrics and normal geriatrics.

The hypothesis of the study were as follows:

1. There are no perceptual features in the speech of normal geriatrics and dysarthrics which overlap.

2. There are no acoustic features in the speech of normal geriatrics and dysarthrics which overlap.

METHODOLOGY:

To carry out this study 48 Kannada words were constructed with the key phonemes /k/ or /g/ with different vowels at various positions (initial, medical and final positions) in the words.

Ten male dysarthrics in the age range of 40-85 years along with ten age matched normal geriatric males were considered as subjects. Speech samples of the subjects were collected individually. The subjects were made to listen to the model word and were asked to repeat the word after the model as naturally as possible. The speech samples were considered for acoustic and perceptual analysis.

ACOUSTIC ANALYSIS:

For acoustic analysis SSL (Speech Science Lab) prgoram of "VAGHMI" software package (Voice and Science System) was used. The following parameters were analyzed:

- Preceeding Vowel Duration (PVD)
- Following Vowel Duration (FVD)
- Closure Duration (CD)
- Burst Duration (BD)
- Voice Onset time (VOT)
- Syllable Duration (Syll.D)
- Transition Duration (TD)
- Speed of Transition (ST)

«

PERCEPTUAL ANALYSIS:

The speech sample of the subjects were randomized and played to an experimental Speech and Language Pathologist for perceptual judgement. The judge was asked to concentrate only on the key phonemes /k/ or /g/ in the word and rate them for thirty-one speech dimensions (The speech dimensions appropriate for this were adopted from the perceptual studies of Darley et al (1969) and Ingram, (1988)) on a five point rating scale, where one represented no abnormality and 5 represented profound abnormality.

RESULTS:

Five way ANOVA was used to find the significant difference between the normal geriatrics groups and dysarthrics groups. The five variables/factors which were considered were:

Group Type (Normal Geriatrics or Dysarthrics)

Age Type (below or above 60 years)

Consonant Type (/k/ or /g/)

Vowel Type (Short or long vowel)

Position Type (Position of the phoneme in initial, medial or final position)

The contributing factors for the significant difference between the normal geriatric group and dysarthric group are summarized in **TABLE (A).**

TABLE (A) : Factors Contributing for the significant difference between normal geriatrics and dysarthrics.

Parameters	Group	Age	Consonant	Vowel	Position
PVD	✓	X	X	X	✓
FVD	✓	✓	✓	✓	✓
CD	✓	✓	✓	X	X
BD	✓	✓	X	X	X
VOT	X	X	✓	X	X
SYLL DV	✓	✓	✓	✓	✓
TD	✓	✓	X	✓	✓
ST	X	X	X	✓	✓

Those marked *v* were found to contribute to the significant difference at 0.05 level between normal geriatric group and dysarthric group.

In dysarthrics, mean of the following parameters:

- Vowel Duration (preceeding and following)
- Burst Duration

- VOT
- Syllable Duration
- Transition Duration and
- Speech of Transition

were found to be increased as compared to that of normal geriatrics. All these were attributed to the slow rate of speech production in dysarthrics. Even in normal geriatrics, duration was found to be increased especially in the group above 60 years.

Qualitative judgement during acoustic analysis indicated the following :

- Presence of multiple burst in dysarthrics and in normal geriatrics above 60 years
- Absence of burst and closure duration in several dysarthrics indicating imprecise consonant production
- Waveform on the spectrogram was continues from one speech segment to another without gaps in between.

Results of perceptual analysis indicates that the speech of normal geriatrics was not always rated as normal along the 31 speech dimensions. It was found that overall intelligibility in normal geriatrics was 95%. However, the mean of severity ratings of

respiratory, laryngeal, resonatory, articulatory and prosodic parameters were mildly affected. This indicated that normal aging has an effect on these speech parameters. In dysarthrics the percentage identification of various speech dimensions and its severity rating was found to be increased and overall intelligibility was 36%, which was attributed to the effect of disease condition upon the normal aging process.

The speech features which were overlapping in the dysarthrics group and normal geriatric group were :

- Audible Inspiration
- Forced Respiration
- Low Pitch
- Pitch Breaks
- Loudness Decay
- Hoarse Voice
- Breathy Voice
- Strained -Strangled voice
- Voice Tremors
- Hypernasality
- Imprecise Consonant
- Distorted Vowels
- Phoneme Prolongation

- Phoneme Distortion
- Phoneme Deletion
- Phoneme Substitution
- Intonation (monotone)
- Stress (reduced)
- Stress (equal)
- Slow Rate
- Overall Intelligibility

The salient features in dysarthrics are:

- Harsh Voice
- Voice Stoppage
- Loudness Variation
- Phoneme Repetition
- Phoneme Addition

The above results implies that perceptually the speech of the normal geriatrics is not entirely different from the speech of dysarthrics but there are overlapping features between the two groups and there are also exclusive speech feature in dysarthrics. Thus both the hypothesis has been rejected.

RECOMMENDATIONS:

1. Spectral parameters can be compared between the normal geriatrics and dysarthrics.

2. By studying a large number of geriatrics normative data can be established for each age group, (between 50-60, 60-70 and 70-80 years).

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APPENDIX - I

LIST OF KANNADA WORDS USED IN THE STUDY:

1	ಅಂಚೆ	17	ಗೆರೆ	33	ನಿಗೂಢ
2	ಗಗ	18	ಅಂಗಿ	34	ಕೊಡು
3	ಕೆಡು	19	ಉಗುರು	35	ಕೊಕೆಗೆರಿ
4	ಬಂಡೂರು	20	ಗಗರಿ	36	ಅಂಕುಡ
5	ಗಾಜು	21	ಫಕೀರ	37	ಬಾಗಿಲು
6	ಚಕಿತ	22	ಕೆಡು	38	ಆಕಾಶ
7	ಕುರಿ	23	ಅನುಕೂಲ	39	ಗೂಬೆ
8	ಗೂಬೆ	24	ಸುಂಕ	40	ಗೊಣಗು
9	[illegible]	25	[illegible]	41	[illegible]
10.	ಯೋಗ	26.	ಕಿವಿ	42	ಗಜ
11	ನಿಗ	27.	ಚಕೋರ	43	ಸಂಕೀರ್ತ
12.	ಸಂಗೀತ	28.	ತರಿಕೆರೆ	44.	ನೀಡು
13.	ಹಾರು	29	ಗುರಿ	45.	ಕೊಡು
14.	ರಂಗೋಲಿ	30	ಆಕರ	46	ನೆಗತ
15.	ಸಗಣಿ	31	ಗೇರು	47	ಒಣಕೊಬ್ಬರಿ
16.	ಕರು	32.	ಕೂರು	48	ಗಂಗೊಳ್ಳಿ

Note: (Words with /k/ and /g/ phonemes in initial, medial and final position combined with various short and long vowels was constructed and randomized)

APPENDIX - II

SPEECH DIMENSIONS TAKEN FOR PERCEPTUAL ANALYSIS

Respiratory Parameters :

> Audible Inspiration
> Forced Respiration

Laryngeal Parameters

> Pitch Level (Low)
> Pitch Level (High)
> Pitch Breaks
> Loudness Decay
> Loudness Variation
> Hoarse Voice
> Harsh Voice
> Breathy Voice
> Strained -Strangled voice
> Voice Stoppage
> Voice Tremors

Resonatory Parameters

> Nasal Emission
> Hyper-nasality
> Hypo-nasality

Articulatory Parameters

> Imprecise Consonant
> Distorted Vowels
> Phoneme Prolongation
> Phoneme Repetition
> Phoneme Distortion
> Phoneme Deletion
> Phoneme Substitution
> Phoneme Addition

Prosodic Parameters :

> Intonation (monotone)
> Stress (reduced)
> Stress (equal)
> Excess Stress
> Slow Rate
> Rapid Rate

> Overall Intelligibility

APPENDIX - III

PERCEPTUAL RESPONSE SHEET

WORD LIST	Audible Inspiration	Force Respiration	Pitch Level (Low)	Pitch Level (High)	Pitch Breaks	Loudness Decay	Loudness Variation	Hoarse Voice	Harsh Voice	Breathy Voice	Strained –Strangled	Voice Stoppage	Voice Tremors	Hyper-nasality	Hypo-nasality	Nasal Emission	Imprecise Consonant	Distorted Vowels	Phoneme Prolongation	Phoneme Repetition	Phoneme Distortion	Phoneme Deletion	Phoneme Substitution	Phoneme Addition	Intonation (monotone)	Stress (reduced)	Stress (equal)	Excess Stress	Slow Rate	Rapid Rate	Overall Intelligibility

Rating Scale:
1. No Abnormality
2. Mild Abnormality
3. Moderate Abnormality
4. Severe Abnormality
5. Profound Abnormality